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editor's letter

The awful weather that has battered the UK and Ireland these past few months comes with an ominous subtext for those of us who accept the overwhelming scientific consensus on climate change. Scientists tend not to make glib assertions, knowing that reality is often too complex to distil into a satisfying sound bite. Given the number of variables affecting climate, it is of course irresponsible to attribute a single extreme weather event to climate change. Sadly this has created an opportunity for denialists who, devoid of any obligation to the truth in all its complexity, are free to promote bogus but seductive arguments that climate change isn't happening, or that humanity's actions aren't a significant part of the reason why. A shameful, lazy tendency in some media to reduce a matter of science to a head-to-head debate has only played into the denialists' hands.

The deluges we've experienced may go some way to exploding the myth that a warmer world will bring the Mediterranean to our doorsteps. Warm air holds more vapour, so while a warming world may come with long, dry heatwaves at times, we can expect the supposed anomaly of this winter to become sinkingly familiar as the world warms. There is a sense echoed in some recent opinion polls that public acceptance of the grim reality of climate change is growing. We must use this opportunity to build the case for decisive action that attempts to both mitigate and adapt to prepare for a warming world. And buildings must play a central role in any such action.

This means constructing and upgrading buildings to lock in carbon emissions reductions for generations to come, and to withstand increasingly volatile weather. In this regard passive house is not a panacea – after all, a passive house built on a flood plan is clearly not a sustainable building – but it offers a clear route to climate change mitigation and adaptation that is sorely lacking elsewhere. Not only does passive house offer a proven, increasingly cost-effective route to achieving energy and carbon reductions of some 80 to 90%. Its attention to thermal bridging, airtightness and robust ventilation creates buildings where both fabric and occupants are protected against extreme weather.

Sadly even much of the more enlightened rhetoric on the need to tackle climate change ignores a solution that makes so much sense. So much of the discussion is focused on the generation of low or zero carbon energy. While this is a worthwhile goal, it offers far fewer benefits than a considered low energy building system such as passive house. Zero carbon energy saves carbon, but it doesn't necessarily put money in people's pockets – at least not without government subsidy. And it doesn't make buildings more comfortable, or protected against the elements – though there is an interesting argument that passive houses with microgeneration may be a smart investment if the events of this winter become more commonplace. How many of the hundreds of thousands of householders in Ireland and the UK who suffered power cuts during February's storms would appreciate a home that remains warm, dry and functional, irrespective of what havoc the elements wreak on the energy supply network?

Regards,
the editor

2012 Business magazine of the year - Irish Magazine Awards

Jeff Colley:
winner - green leader award - Green Awards 2010

Construct Ireland:
winner - green communications award - Green Awards 2010

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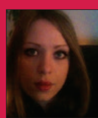
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Disclaimer: The opinions expressed in Passive House Plus are those of the authors and do not necessarily reflect the views of the publishers.

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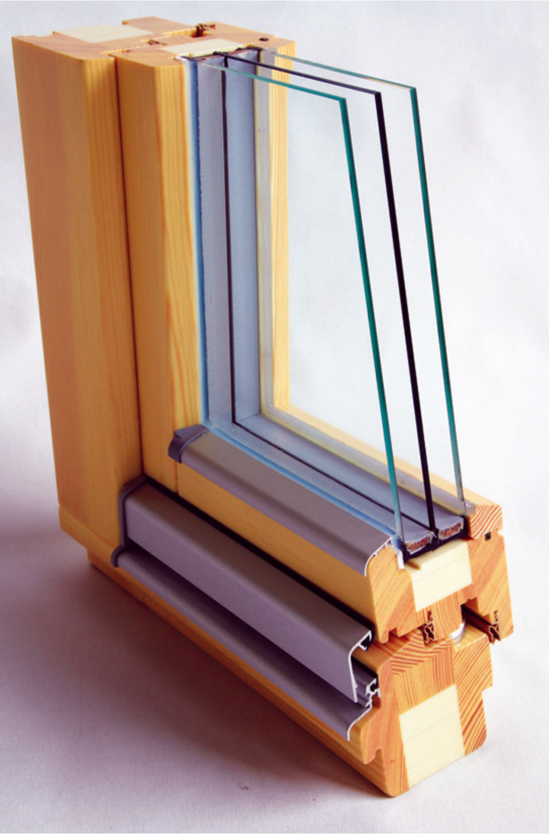
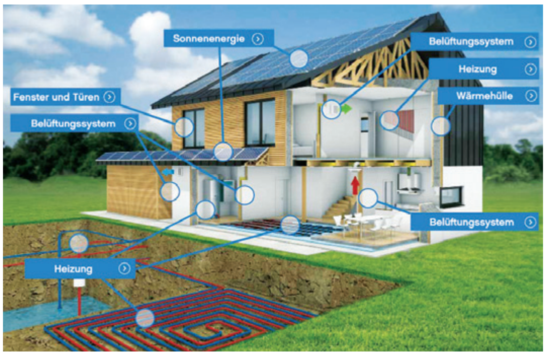




New passive house products certified

Over 100 low energy building products and systems gained passive house component certification in 2013. With new passive house components continuing to be certified at a quick pace, Passive House Plus will endeavour to keep pace and showcase some of these in each new issue of the magazine.

Lumar, a Slovenian manufacturer of prefabricated timber frame houses, had its second construction system certified at the end of 2013. The Lumar Passiv Energy system is an advancement on the company's original Lumar Passiv timber frame system, which was certified in 2009. Lumar has built three certified passive houses to date — two in Slovenia and one in Austria.

Meanwhile the Lithuanian window manufacturer Zyle Fenster has achieved certification for its Passive Europe triple-glazed window, which achieves a U-value of 0.79 W/m²K, and is available in timber-only or aluclad options. The company uses FSC & PEFC certified timber and water-based finishes, and specialises in large-scale architectural as well as ordinary domestic glazing systems.

Another Lithuanian company, the ventilation manufacturer Komfovent, has also achieved passive house certification recently for its Domekt Rego 450VE heat recovery ventilation system, the first rotary wheel MVHR unit to gain passive house certification. Komfovent will exhibit the system, and its whole range of air handling units, at this year's Ecobuild at stand N2129.

Passive House Plus will feature new certified components in each issue of the magazine, so please contact us at info@passivehouseplus.ie if your company has recently had a product certified by the Passive House Institute.

(pictured) Zyle Fenster's Passive Europe triple-glazed window, the Lumar Passiv timber frame system, and Komfovent's Domekt Rego 450VE MVHR system, all of which gained passive house component certification recently

Passive house in the spotlight at Ecobuild

Passive house will be represented stronger than ever at this year's Ecobuild on 4 to 6 March, with a series of events throughout the exhibition focused on the world's leading ultra low energy building standard. Passive House Plus will also be at this year's exhibition — come find us at stand S800.

Meanwhile the Passivhaus Trust has compiled a list of relevant events and published them on its website at passivhaustrust.org.uk.

These include sessions on how to scale up passive house to multiunit projects and maintain quality, and designing for quality and comfort in passive buildings. There will also be sessions on delivering retrofit at scale and standardised passive house school design.

Saint-Gobain will run a series of passive house seminars at its stand, N750. The Passivhaus Trust will also launch the 2014 UK Passivhaus Awards at Ecobuild, at 16.30 on Wednesday 5 March at stand S510/11, hosted by Advantage Austria.

The trust is also involved with the Regeneration Film Festival 2014, an open-entry filmmaking competition at Ecobuild for all those involved with the design, use and development of a sustainable built environment.

Ecobuild takes place from 4 to 6 March at the Excel Centre in London.

News

Sunday Times launches award for waterfront passive house

Submissions are now being invited from registered UK Architects to an open design competition for EcoHaus, a waterside holiday home designed to passive house standards in a managed nature reserve located at Silverlake near Warmwell, Dorset.

Designs are encouraged to embrace innovative products and concepts, while ensuring the submission is buildable, replicable and compliant with building regulations to conform to NHBC/Premier Guarantee standards.

The design competition forms part of the Sunday Times British Homes Awards and is being run in partnership with the Passivhaus Trust, Habitat First Group, Kingspan Insulation and the Architect's Journal, and is sponsored by Homebase.

Up to ten designs will be shortlisted and published in the Sunday Times in June 2014. The scheme that receives the most reader and online votes will be declared the winner of the competition. The winning design is planned to be built in multiple units at one or more of the Habitat First Group's sites.

Judges are looking for proposals of "stunning architectural merit" that are environmentally smart and offer a healthy environment for the occupants. Designs are invited for both an individual home and group of homes.

Full details and a design brief are available at britishhomesawards.co.uk. To be eligible for participation in the competition all entrants must notify the promoter of their intention to submit a design by 4 April 2014. The registration fee is £100 plus Vat. Submissions are due by 2 May 2014, and the shortlist will be announced in June.

(above) Lifetime Dwelle.ing, the winner of the Britain's Future Home award at the Sunday Times British Home Awards 2013

Viessmann to showcase pioneering fuel cell system at Ecobuild

Leading international heating systems manufacturer, Viessmann, will unveil the first mass-produced, commercially available, domestic fuel cell in Europe at Ecobuild on 4-6 March. Viessmann and Panasonic have jointly developed the Vitovalor 300-P polymer electrolyte fuel cell-based micro combined heat and power system (mCHP), which goes on sale in Germany this April. By 2020, Panasonic and Viessmann expect a five-digit number of systems to be installed in Europe.

Comprising a fuel cell unit, peak load boiler and hot water tank, Viessmann – which is celebrating 25 years in the UK in 2014 – says the system reduces CO_2 emissions by 50 per cent compared to the separate generation of heat and power.

Several other new products across the Viessmann range will be showcased at Ecobuild: the new version of the solar tube display, the Vitosol 200-T, has wider, but fewer tubes for greater efficiency and for reducing installation time and the risk of breakages.

Ecobuild will also mark the launch of Vitoflow, a software and hardware system which supports automated hydraulic balancing of radiator circuits, increasing the heating system efficiency by up to 15%. The technology works with all Vitotronic 200 controlled heat generators up to 150 kW.

Products from Viessmann's established range will be at the show, including the Vitobloc 200 EM5, a CHP unit for direct and indirect space heating and instantaneous hot water generation, the Vitodens 100-W, 111-W and 200-W popular wall hung gas fired condensing boilers, the Vitocell 300-B hot water cylinder, the Vitosol 200-F solar thermal flat panel and the Vitocal 200-S split air source heat pump.

As the diversity of its exhibits at Ecobuild demonstrates, Viessmann prides itself on its comprehensive range of individual solutions for energy efficient systems. It's also a persistent champion of sustainability, running its highly successful Efficiency Plus project at its manufacturing facilities in Allendorf, Germany, to demonstrate how any business or household can actively promote climate protection and reduce their energy bills. The project has already saved 66% of fossil energy use and cut CO_2 emissions by 80%.

To see Viessmann at Ecobuild visit stand N1820/21.

(right) The Vitovalor 300-P fuel cell-based micro CHP system will be launched at Ecobuild

News

Urban Front launches triple-glazed side and storeylites

Following the launch of Urban Front's E98 passive house certified doors last September, the manufacturer has announced that it can now provide its range of doors with triple-glazed sidelites and storeylites.

The company can also now provide doors with glass vision panels that comply with the passive house standard.

"Passive House certification for these extra products is pending and should be granted within the next few months," said Elizabeth Assaf of Urbant Front.

The company's range of doors – which is available in pivots and hinged options up to 2400mm high and 1200mm wide in 15 designs – comes in six hardwoods: European oak, western red cedar, iroko, American walnut, fumed oak and wenge. The company also supplies painted doors in any RAL colour.

(pictured) Urban Front's doors are now available with triple-glazed sidelites and storeylites

Ecological Building Systems course up for CIBSE award

Ecological Building Systems' course, Better Building, Putting the Fabric First, has been shortlisted for the CIBSE Building Performance Awards, under the training for building performance category. The Awards recognise the businesses, teams, products and projects that demonstrate engineering excellence in the built environment.

The awards focus on actual, measured performance, not design intent or performance specifications. Judged by a panel of industry leaders, winners of the awards are acknowledged as best in class.

The course is delivered by Ecological Building System's skilled and experienced technical staff. The course combines the latest developments in low energy and passive house building technology in both new builds and retrofits, with practical guidelines on the application and delivery of a low energy building fabric.

Ecological's ethos is to achieve better building by adopting a fabric first approach to design, with the use of more natural materials to optimise building performance and durability. Ecological have a bespoke centre of knowledge showroom at their base in Athboy, Co Meath, Ireland and are also based in the UK in Carlisle, Cumbria. The training centre in Athboy is open to both building professionals and the general public by appointment.

The company said that it has prioritised the need not just to supply a high quality product, but also provide back-up with equivalent technical support and training. Ecological's supply partners include Pro Clima, Gutex, Calsitherm and Thermo Hemp.

The awards took place on Tuesday 11 February in London. The training award was won by BRE Group Training's BREEAM Accredited Professional course.

News

Optiwin seeks UK manufacturing partners

Leading passive house and low energy glazing brand Optiwin has announced that it is looking for small to medium sized manufacturing partners in the UK via Berkana Green, its exclusive licenced sales agent for England, Scotland and Wales.

Optiwin is seeking manufacturers with a track record of quality in timber craftsmanship who may be interested in adding a range of certified passive, low energy and ultra low energy window and glazing products to their portfolio.

"We're trying to support the transfer of highly specialised manufacturing knowledge to the UK," says Berkana Green CEO Conor Ryan. "We're committed to developing a network from Scotland all the way down to Land's End of local manufacturers, suppliers and fitters."

"What we're seeking is competent, honourable and knowledgeable businesses who want to expand their existing range into passive house, low & ultra low energy components."

Meanwhile, Berkana Green has also been appointed by Freisinger Fensterbau as Optiwin sales agent for England, Scotland and Wales, providing the glazing range directly from Optiwin's Austrian manufacturing base. Conor Ryan, a certified passive house consultant, has been involved with the Optiwin group for many years in manufacturing, technical, service, fitting and management.

Optiwin UK will be exhibiting at Ecobuild at stand S 410/11 & S510/11, and at the International Passive House Conference at stand 5.6.

(pictured) (l-r) Optiwin technical director Dennis Khun; Optiwin directors Josef Freisinger & Herbert Noichl; and Berkana Green CEO Conor Ryan.

Good design & installation crucial for MVHR — Total Home Environment

Gloucestershire-based ventilation experts Total Home Environment (THE) have warned that heat recovery ventilation systems can fail to perform as expected if not designed, installed and commissioned properly, with quality rigid ductwork.

The company provides a complete design, supply, installation and commissioning service for Genvex MVHR systems with integrated heat pumps.

As part of its service, THE undertakes room-by-room heat loss calculations, rather than performing one whole-house calculation, to ensure the system is properly sized.

Associate director, Clarissa Youden also emphasised the importance of installing high quality, rigid ductwork. "As soon as you get cheap flexible ductwork the COP goes out the window."

She also emphasised that exact control is essential to get the most from an MVHR system. "Most systems tend to have a very simple controller — either it's on or off, or at the very most you get a boost function."

But she said Genvex units come with a sophisticated control system that is equipped with a 24/7 timer, room and external temperature monitors, boost function in four increments, plus an SD card that can hold two years of data. The fan power can also be changed in increments from one to 99% to balance airflow correctly.

"What is the point of having an efficient machine if you can't control it to fit your lifestyle and your home's fabric?" Youden said.

THE supplies the Genvex Premium series of heat recovery ventilation units which include a micro air-to-air heat pump for space heating.

"The best thing about heat recovery ventilation is that all your ducting is already there. Why not add 3kW of heat into that air and save yourself a space heating system?"

The company also supplies the passive house certified Genvex Combi 185 unit which provides heat recovery ventilation and includes an integral heat pump for air and domestic hot water.

(above) A Genvex Premium heat recovery ventilation system featuring integrated micro air-to-air heat pump

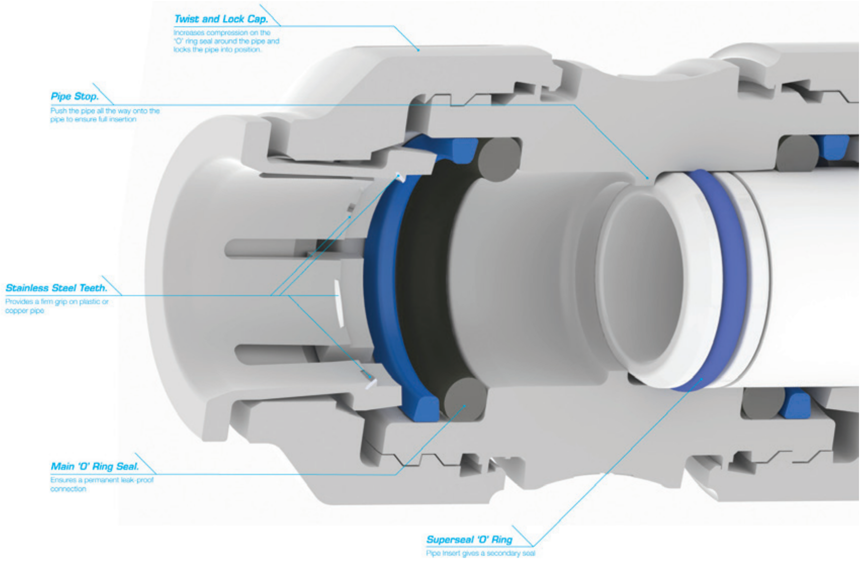
News

SpineLock appointed plumbing supplier to JG Speedfit

Spinelock has appointed JG Speedfit as the exclusive supplier of plumbing components and pipework systems for their prefabricated houses. The JG Speedfit team worked alongside SpineLock to come up with a “seamless plumbing technology that is compliant with the factory fit methods of manufacture”.

The SpineLock Group is a UK-based manufacturer of highly engineered prefabricated houses. The dwellings are produced off-site, and the manufacturing process starts with aluminium extrusions that form the structure. These are then built in sections and “zipped together” on site. The wall elements are then filled with insulating foam in the factory. The incorporation of a rainwater harvesting system, solar panels and the general plumbing installation is done in advance, which allows for a time-efficient on-site assembly.

The JG Speedfit push-in fitting is ideal for such projects as it reduces installation time by 50%, according to the company, and dismantling and modifying the plumbing circuit is easier than ever before. The plumbing components supplied to SpineLock also include the new addition to the JG Speedfit product range, the JG Layflat pipe. The product is designed to remain flat and be ultra flexible, allowing greater control and ease of movement, making it possible for a single person to meander and route the pipe as they wish, ensuring a swift, smooth and easy installation. The lightweight polybutylene material that the JG Layflat pipe is made of does not overload the construction of the house and does not affect the transportation of the prefabricated building elements.



Derick Wilson, CEO of SpineLock, commented: "The JG Speedfit team showed great expertise and know-how that proved invaluable to us. They were able to demonstrate how the various push-fit systems could be configured to meet our manufacturing requirements. As our houses are 100% off-site factory built, we needed to completely rethink the plumbing installation approach. With JG Speedfit’s expert help we are now able to fit plumbing systems into our buildings during the assembly process, which then comes together as expected when the house is finally constructed on-site.”

(above) Prefabricated house manufacturer SpineLock has found that JG Speedfit’s push-fit systems are well matched to its manufacturing requirements

Greentherm becomes sole UK distributor for Icynene spray foam

Cumbria-based Greentherm Insulation is now the sole distributor of Icynene spray foam in the British Isles.

Greentherm was established by Gerry Sheridan of Irish Icynene distributor GMS Renewable Products, which was founded in 2004 and moved into the UK market in 2007.

Sheridan is partnered in the business by Paddy Leighton. “Paddy has over 30 years experience in the construction industry and has an intimate knowledge of Icynene spray foam insulation”, Gerry said.

He added that Greentherm’s aim will be to develop a network of Icynene spray foam contractors, to provide them with support and to grow the market for Icynene in the UK.

On the market in Canada since 1986 and in the British Isles since 2004, Icynene is a BBA and ETA certified water-blown spray-foam insulation that provides both airtightness and insulation in one product.

(right) Icynene insulation, available in the UK via Greentherm Insulation

News

Lindum focuses on biodiverse green roofs at Ecobuild 2014

Leading green roof and turf specialist, Lindum, will be focussing on pollinators and biodiversity at this year's Ecobuild exhibition which takes place on March 4-6 at ExCel, London. At the forefront of green roof technology relevant to UK climate conditions, Lindum has developed pre-grown vegetation mats containing mixtures of wildflowers, herbs, perennials and sedums can provide a wonderful flowering display and encourage biodiversity.

Lindum managing director Stephen Fell says: "Green space is increasingly seen as an important part of helping our cities to adapt and mitigate against the effects of climate change. Green roofs play a significant role in this. Our green roof mats have been specifically developed to provide a habitat for conserving biodiversity in urban environments. Pollinating insects, such as common butterflies, moths, hoverflies and bees, have been declining over the last 50 years, so the big potential to change this is with urban areas on roofs."

Lindum's range of green roof mats provides biodiverse green planting to attract wildlife and create colour. Developed with green roofs expert Professor Nigel Dunnett of the Department of Landscape at the University of Sheffield, the mats contain a range of drought tolerant plants that will flower from April to September, attract pollinators and flourish in the conditions created on a green roof.

Sustainably grown in Yorkshire, Lindum's green roof mats are lightweight and easy to install, with plants ready established and growing in a strong felt mat made from recycled British textiles.

The range includes: Lindum Biodiverse Green Roof Mat, which provides a biodiverse, colourful and drought tolerant range of wildflowers, herbs, flowering perennials and sedums that will flourish in the conditions created on many types of green roofs; Lindum SedumPlus Mat, which is sown with a blend of 16 stunning varieties of sedum to combine drought tolerance with extended interest and colour throughout the growing season; and Lindum Wildflower Meadow Mat, a taller growing mix of native wildflowers and grasses growing in a moisture retentive biodegradable felt mat to provide the appearance of a true wildflower meadow on a roof.

Lindum's green roof mats can be applied to flat, sloping or curved roofs and advice can be given on build-up profiles and appropriate substrate depths. Lightweight substrate, drainage layer and edging trims can be supplied as a green roof package.

Visit the Lindum stand S1700 at Ecobuild 2014 for advice and more information or visit www.lindumgreenroofs.co.uk

(above) Lindum's Biodiverse Roof Mat

Rainwater Harvesting Ltd gets WRAS approval

Rainwater Harvesting Ltd has announced that both its direct feed and award winning gravity-fed Rain Director system have achieved Water Regulation Advisory Scheme approval, ensuring that they comply to all applicable UK regulations.

The company said that as demand on mains water supply increases and water rates rise, there has never been a better time to include rainwater harvesting in a building project.

Rainwater can be used for any non-potable application including toilet flushing, washing machines and outside use, and can cut use of mains water by up to 50%.

Rainwater Harvesting Ltd was formed eight years ago after one of its directors, Adrian Lester, put a harvesting system in while adding an extension to an existing property. The components were delivered as a "bag of bits", making it a big challenge to the builder. This inspired Lester, a production engineer, to set up the company.

The UK manufacturer has developed complete systems with the trade and end-user in mind. Its systems are designed to be simple to install, and with the advantage of shallow dig tanks the company says costs have been significantly reduced, adding that the user-friendly features of the Rain Director means that water is available in any eventuality, and running costs are less than 1p/per person/day.

The company also runs rainwater harvesting installation training courses on behalf of The United Kingdom Rainwater Harvesting Association.

(left) Rainwater Harvesting Ltd's WRAS approved Rain Director system

News

Carbon Legacy: planning ahead key to energy efficiency

Renewable energy experts Carbon Legacy have advised those undertaking low energy and renewable energy projects that early planning is key to achieving quality and cost effectiveness.

""If you can, involve us at an early stage so we can guide you down the road of fabric first principles to get low energy use designed into the building in a cost effective way," said the company's managing director Dave Hill. "We can also show that the joy of living in a low energy building is not only a pleasure but is a profitable investment."

"Knowing who to trust in the world of low energy and passive buildings is unfortunately still a tricky journey as many have found to their cost," said managing director David Hill. "In the UK we are at the beginning of that journey and the industry still has a lot of catching up to do.

"If you can, learn from those with hands-on experience, who are willing to be honest about problems encountered, costs and what really works," he said.

"Many self-builders and property renovators come to Carbon Legacy for free advice on everything from insulation, building techniques and materials, ventilation, solar panels and renewable heating." Hill said the company then provides designs and plans for minimalist renewable energy systems.

With over 1,000 residential and commercial buildings completed, including the first UK code six homes in Northampton back in 2008, Carbon Legacy has a wealth of practical knowledge to share and are accredited MCS installers for solar PV, solar thermal, heat pumps and biomass boilers.

"By using only the best German, Austrian, Dutch and American equipment, we give our customers top quality competitive installations that we monitor for their life," he said.

The company also offers low cost energy monitoring systems that measure total consumption, power export, solar generation, heat generation, water usage, individual circuit and appliance consumption. Both Carbon Legacy and the end user can monitor this data from anywhere online.

Carbon Legacy designed and supplied the solar photovoltaic system at Tina Holt's featured low energy upgrade on page 56 of this issue.

(above) Carbon Legacy MD David Hill practiced what he preaches by retrofitting solar PV, solar thermal and a ground source heat pump to his own home, a barn conversion in East Leake, Nottinghamshire

Windhager to launch new BioWin 2 pellet boiler at Ecobuild

Windhager will launch its latest development, the BioWin 2 wood pellet boiler, at Ecobuild 2014.

The BioWin 2 has been designed as a space-conscious appliance and can be installed within an alcove as it requires no servicing clearances either to the left, right or the rear, and minimal clearance to the front. All cleaning and servicing is achieved from the front of the unit. Windhager said that no other wood pellet boiler achieves these minimum clearances, making it a "real innovation and ideal for many different properties".

BioWin 2 is available in four outputs from 10 to 26kW all with a 30% modulation range for maximum efficiency. The units features fully automated cleaning and ash removal to an integrated ash container, ensuring full efficiency and long intervals between cleaning and servicing. A patented sliding grate within the burner bowl and close monitoring of the combustion guarantee maximum combustion efficiencies.

The new boiler is available as a hand feed version from its integrated pellet hopper, or as an auto feed boiler from a bulk pellet store. Because of Windhager's pellet suction feed system, it can be installed up to 25 metres from the boiler.

(right) The BioWin 2 pellet boiler is to be launched at Ecobuild

News

DVS shines a light on low energy Doncaster home

Suffolk-based Daylight and Ventilation Solutions (DVS) recently completed work on the design and installation of a large triple-glazed roof window at a new ultra lower energy home in Doncaster.

DVS designed, supplied and installed a dual-pitch roof light system at the property, employing the Lamilux PR60energysave roof glazing system, which is certified as an advanced component by the Passive House Institute.

"It provides a link between the main house and what was an old barn," said Daniel Boughton of DVS.

The new dwelling sits on the site of an old farmhouse, and part of the planning condition was that the new dwelling be built on the same footprint, reusing as many of the original materials as possible. The house is of cavity wall construction with an outer skin of stonework and brick, and is aiming to meet the passive house standard.

DVS has also announced that the full Lamilux range of daylighting and ventilation products has been awarded with environmental product declarations (EPDs), which verifies the life cycle impact of its products. This enables specifiers to choose products with the lowest environmental impact. The EPD looks at factors such as the extraction of raw materials, manufacturing, recycling and disposal, and global warming potential.

"We basically commissioned it for all of our products to identify the potential environmental impacts," Daniel Boughton said. "It just goes to prove we are at the cutting edge. We take very seriously the life cycle of our products."

(above) DVS has installed substantial triple-glazed roof windows at a new low energy home in Doncaster, which is aiming for the passive house standard

Change procurement to deliver passive house at scale — EH Smith

John Cave, sustainability director at EH Smith Sustainable Building Materials, has advised that major changes are needed to procurement in order to deliver passive house at scale. Cave pointed out that, with around 250-300 certified passive buildings in the UK, currently less than 0.25% of homes built per year are to the passive house standard.

"The late Howard Liddell, an outstanding architect of low energy buildings, had a mantra that the cost of the building had nothing to do with its low energy characteristics, but that it reflected the thought through design and subsequent implementation of that design," Cave said. "There are a number of projects that have already been delivered within the same budget as a non passive house building. There are also other projects where the costs have been incredibly high – however, the same can be said for any type of building."

"Passive house demands a rigorous and robust design and construction process with an unrelenting attention to detail. When put in the traditional design and build process, the compromises begin. To win on a design and build contract, the contractor is forced to go through a 'value engineering' process which is aimed at reducing the cost of construction to be the lowest price in the tender process. The easiest way to do that is to substitute products from the original specification, but this is counter-intuitive when it comes to passive house."

He continued: "If we accept that the control of the process is paramount, we have to change the way we procure. There are a number of enlightened clients that have changed to a contract where that control can continue throughout the process. If we are to truly scale passive house, construction clients need to be aware that the way they procure buildings is a real barrier to operational efficiency.

"It has already been said by so many in the industry, but we really do need to join up the dots between the construction and operation costs; everyone in the industry has a responsibility to educate clients in this. Research carried out by Constructing Excellence shows that for every £1m spent on construction, £5m is spent on operation and maintenance with energy as the single biggest contributor to ongoing costs. Passive house offers a real opportunity to reduce that ratio."

EH Smith Builders' Merchants have been involved in material specification and supply on numerous passive house projects since 2008, including self-build projects, scaled social housing, schools and commercial buildings.

News

Vortice to exhibit at Milan expo in March

Energy efficient ventilation specialist Vortice will be exhibiting at Mostra Covengo from 18-21 March 2014 at the Fiera Milano Exhibition Centre in Rho, Milan. The company will be unveiling several new products including additions to their family of heat recovery systems.

The HR250 Prana is designed to ventilate a three bedroomed house, which may have a kitchen, bathroom, ensuite and a WC and utility room downstairs. The HR350 Avel is designed for a large family house, which would perhaps have a kitchen plus seven wet rooms. These two new heat recovery units, together with the HR200, Prometeo and HR Invisible, bring to five the number of heat recovery systems offered by Vortice.

On the exhibition stand will also be the new twin fans and acoustic fans launched by Vortice this year. The new range of twin fans and acoustic box fans are designed to run sufficiently quietly for use in applications like museums and libraries.

Vortice general manager Kevin Hippey commented: "We're looking forward to demonstrating the advances we have made both in heat recovery systems and in twin and acoustic fans at Mostra Covegno. Vortice is now the obvious choice for heat recovery as we have a range which covers all areas of the market."

Vortice has focussed on energy efficient ventilation systems for many years and supplies extractor fans, air handling units and heat recovery systems worldwide.

(above) Vortice's stand at the 2012 Mostra Covegno event

Swedish tests reveal ThermaSkirt efficiency

KTH Royal Institute of Technology in Sweden has published a paper investigating the thermal performance of radiant skirting boards using Discrete Heat's ThermaSkirt heated skirting board as the test sample. The experiment evaluated the capacity of radiant baseboards to work in conjunction with heat pumps.

The test of both ThermaSkirt and a range of conventional radiators provided data that showed radiant baseboards had a significantly higher heat transfer ability of 50% more than panel radiators. The research also shows the compatibility of heated skirting boards and heat pumps to be more effective than using traditional radiator panels in a heat pump system.

The Swedish government has implemented a number of measures over the last decade to help reduce electrical peak loads and energy consumption during the heating season. From 2006, homeowners could be refunded up to 30% of conversion costs when converting from electric to alternative heating systems. As a result the installation of heat pumps increased with the one-millionth heat pump put into operation in 2010 for residential use.

Heat pumps work most efficiently when coupled with low temperature heating systems. Heated skirting boards benefit from a low fitted position, causing a high transferred convective heat flux from the skirting board to the room air. Installed at the base of walls, they are exposed to colder room air along their entire length which in turn increases the thermal gradient and its ability to transfer heat to the room.

The aim of the study was to design a valid equation for the heat output for all baseboard heights and excess temperatures as the present equations are limited to certain heights and a specific temperature range. The results show that the heat emission increases by 2.1% per cm of height of the heated skirting board and doubling the water flow only increased the heat emission by 4.5%. The paper concludes that heated skirting board should be used at maximum possible height and with the current guideline value of 100 Pa/m for waterside pressure loss for the system design.

(above) Discrete Heat managing director Martin Wadsworth pictured with the ThermaSkirt product that was used in the KTH Royal Institute of Technology investigation

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Low environmental impact ☐

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EU resolution may be low energy light at end of tunnel

*Progress on energy efficiency in the EU has been slow. But now, writes EuroACE secretary general **Adrian Joyce**, a breakthrough might finally be on the cards*

The malaise of the EU continues into another season. The talk – and reality – of high unemployment, zero growth and declining quality of life persists despite the efforts of the EU and its member states over recent years. But maybe the European Parliament has just shone some light on the situation and the end of the tunnel is just around the corner?

On 5 February, a meeting of the European Parliament in Strasbourg voted by a convincing majority (341 to 263) to adopt a resolution on climate and energy policy that calls on the EU to introduce binding targets for 2030 on energy efficiency (40%), renewables (30%) and greenhouse gas emissions (at least 40%). The result of the vote was much more ambitious than many EU observers expected, and sends a strong signal of intent to the other legislator in the EU – the European Council (ie the member states).

The expectations of EU observers were that the conservative voices in the European Parliament would be heartened by the weak proposals included in the European Commission's own 2030 package (released on 22 January). This calls for a binding target for greenhouse gas emission reductions of 40%, linked to a binding target for the share of renewables to be at least 27% by 2030. The commission's view is that anything more ambitious would not be acceptable for the member states.

The commission's package is notable for the near complete omission of energy efficiency, which it attributes to bad timing. Indeed, a review of the progress towards achieving the 20% energy efficiency target by 2020 is expected in July 2014 and will be based on plans to be submitted by member states under the provisions of the Energy Efficiency Directive. The commission has argued that any proposals for energy efficiency for 2030 would be a breach of confidence in the member states and so it has postponed its announcements on energy efficiency until the review of progress to the 2020 targets is completed.

Coming back to the resolution adopted by the European Parliament on 5 February, the fact that it calls for the setting of ambitious binding targets in the three policy fields puts the commission in a tight spot. The commission knows that there is great potential in energy efficiency and that many actors are calling for ambitious action in this field as it is the sector that can quickly deliver on jobs, security of supply and economic revival (including boosting manufacturing in the EU).

The next step will be a debate by the heads of state at the EU Summit at the end of March, and several member states are expected to speak up in favour of high ambition on energy efficiency. Interestingly, Germany's new coalition government is supportive of three binding targets and it wields a lot of influence in the council. Also expected to be in support of ambition on energy efficiency are Ireland, Denmark and, significantly, the current presidency, Greece.

The businesses represented by EuroACE are encouraged by these developments as the parliament's resolution also includes a call for a sectoral buildings target for energy efficiency improvements. This is exactly the double combination that we have been looking for – a call for an overall binding energy efficiency target for 2030 and a sectoral target for buildings, the sub-sector that has the most potential to offer.

Studies have shown that the introduction and implementation of an ambitious target for buildings for 2030 would bring very substantial financial, economic, environmental and social benefits to the EU. The benefits have been quantified as a boost in annual turnover, by 2020, of about €670 billion for the construction sector; the creation of up to two million new local, sustainable, direct jobs; a rising annual boost to public finances estimated at €39 billion in 2020 and €78 billion in 2030; increased health and well-being resulting from lower air pollution and a significant drop in CO_2 emissions as demand for heating and cooling of buildings drops.

EuroACE and several other stakeholders have been working towards these goals for many years, often with the feeling that success will always elude us. With the vote of the parliament now behind us, with the strong political call to action that it represents and an open door for the commission to display ambition on energy efficiency in the review required under the Energy Efficiency Directive, maybe there is some light at the end of the tunnel.

EuroACE represents Europe's leading companies involved with the manufacture, distribution and installation of energy saving goods and services for buildings. EuroACE members have a total turnover of around €140 billion per year in efficiency-related business and they employ approximately 172,000 people in these activities in Europe. The mission of EuroACE is to work together with the EU institutions to help Europe move towards a more efficient use of energy in buildings, thereby contributing to Europe's commitments on climate change, energy security and economic growth.

"The commission knows that there is great potential in energy efficiency and that many actors are calling for ambitious action in this field as it is the sector that can quickly deliver on jobs, security of supply and economic revival."

The passive alternative to controversial grid upgrade plans

Partly devised to sell electricity to the UK, the divisive plans to upgrade Ireland's grid to facilitate increasing amount of wind energy should be replaced with a smarter alternative solution, says architect ***David Hughes****, arguing that going back to first principles with the Hughes Energy Initiative can save Ireland billions.*

The central message behind the passive house concept is to reduce energy demand to a minimum – regardless of whether the energy is supplied via traditional fossil fuels or newer renewable energy sources. The target figure for space heating in a passive building is 10W/m². When one considers that a candle emits 30W of heat energy, and that a typical passive living room could be heated with eight candles, the potential reduction in energy demand is startling.

To date in Ireland we have embraced the passive house mindset and have built good exemplars, but most agree that the message needs to get out into the wider public arena. Over the last few months the issues of pylons, high voltage power lines and wind farms have become headline news.

Over 35,000 submissions were made to state-owned grid operator EirGrid on their Grid Link project. While cynics may characterise any submissions as nimbyism, it pays to stay objective and to look behind the reasons why we are building the Grid Link project and its related National Renewable Energy Action Plan (NREAP) projects consisting of Grid25, wind farms, interconnectors, substations and fast response gas power stations.

NREAP seeks to provide 40% of Ireland's electricity via wind energy but how many know the cost of this financially, and also the unintended consequences of loss of visual amenity and social divisiveness in areas where these pylons and wind turbines will be located? To date most commentators have said that while these projects do have negative effects, what is the alternative?

In my energy initiative paper, I set out a roadmap to achieving Ireland's NREAP 20:20:20 targets and the more recent Energy Efficiency Directive 2030 and 2050 targets in one step. This is a real alternative that comes out of a passive house mindset.

Put very simply and in very round numbers the following is the choice on offer.

Ireland can provide for 40% of electricity from wind energy with a spend in the order of €30 billion plus. This is to provide an additional 1500MW of wind on the grid, however it will also nearly double the cost of electricity and will not save a single kWh of electrical demand – just increase the supply.

So what's the alternative?

Buildings account for 40% of energy usage – both electrical and non electrical – nationally. Investing the same €30bn plus in retrofitting buildings will save 75% or more, reducing the energy demand of buildings from 40% to 10% of the current national demand. This will free up 30% of the energy consumed. This equates with 1500MW of electrical power and €2bn per annum off Ireland's annual energy imports bill which currently costs €6.5bn.

Reducing electrical demand by 1500MW has the same benefit as adding 1500MW of electrical wind power, including all of the CO_2 reductions, but in a truly passive way — not one more wind turbine or pylon needs to be built to achieve this benefit. In addition instead of increasing electricity prices it will lower energy bills including electricity by 75%. The net result is that every €100 spent on energy today for buildings will drop to €25. Furthermore as the demand for energy will have dropped, the electricity supplied by existing wind power will automatically grow to 33% of national consumption. The remaining 7%, incidentally, can easily be provided from renewable biomass from state-owned woodlands.

So which would you choose? Spend €30bn plus increasing electrical supply by 1500MW and doubling electricity costs? Or redirect that €30bn into retrofitting and reduce energy demand from buildings by 75%, saving €2bn per annum of energy imports and reducing electrical demand by 1500MW?

Some might argue we can do both but this is folly. There isn't an unlimited pool of capital available, we need to compete for funds and of course we have to pay them back. If we spend the €30bn increasing electrical supply and doubling electricity costs and then another €30bn retrofitting the building stock any future benefit of retrofitting the building stock will be wiped out. In effect we will have spent €60bn only to bring electricity bills back to the level that they are at today.

If we just leapfrog straight to the alternative option we will get a return on our money from day one, reduce our energy consumption and achieve our NREAP commitments. We will also create jobs and improve our market competitiveness. One hesitates to use the phrase no-brainer but this choice clearly falls into this category.

Ireland – just like the UK – has to carry out the Energy Efficiency Directive 2030 and 2050 reductions – that's a given. This fact alone should make us re-evaluate the commitments under the NREAP 20:20:20 targets of 40% wind energy and redirect them now to achieve NREAP and EED in one streamlined step.

The reduction in capital required is over €30bn and we will get this €30bn back meaning the saving is €30bn. This is a very good return on Ireland's early adoption and understanding of the passive house message.

So there is a clear financial reason to pick this option, but not everything can or should be reduced to pure monetary terms. Let's not forget the 35,000 people who made submissions. Their public participation brought about this alternative. However to complete the process they started this idea needs to be supported by as many people as possible, and adopted by the government, and presented to the EU as Ireland's energy efficiency directive roadmap.

We are all working and living in buildings right now – this is where the solution is and where we will all feel its benefit. So let's get in early, adopt the solutions now, and get the added benefit of exporting our expertise and learning to other countries as well.

To read the Hughes Energy Initiative in full visit www.passive.ie

INTERNATIONAL SELECTION

This issue's selection of international buildings include Spain's first passive houses built from straw bales, an architecturally striking energy-plus office building in Denmark, and an Austrian family home that marries ecology, comfort and delightful design.

House under the Oaks, Eichgraben, Austria

Architect Juri Troy's House Under the Oaks is a low budget passive house for an Austrian family. With a minimum footprint, and a wide outstretching wooden box on six columns, it offers a living area of about 100 sqm. The whole structure was built on site last year from prefabricated FSC certified timber and insulated with wood fibre insulation up to 60 cm thick. The interior is clad in local wood too, with a simple white pigmented oil coating.

A ground source heat pump and heat recovery ventilation system help meet the tiny space heating demand — just 9 kWh/m^2/yr — and there's ten square metres of solar PV panels too. Another interesting detail: there's only one internal door in the whole house, for the guest toilet. The architects call the house a "new prototype for affordable living" in ultra low energy homes. ▶

Photos: Juri Troy Architects

Syd Energi HQ, Esbjerg, Denmark

The new headquarters of Danish energy firm Syd Energi not only meets the passive house standard, it produces more energy than its mechanical systems consume. Designed by GPP Arkitekter, and completed last year, the 9,000 square metre landmark structure houses 420 staff, and is one of the world's largest certified-passive buildings.

The roof features nearly 2,000 sqm of solar PV modules that produce 247,000 kWh of electricity per year. A 360 panoramic walk around the top floor gives an amazing view of the port city of Esbjerg, surrounding farmland, and out to the North Sea.

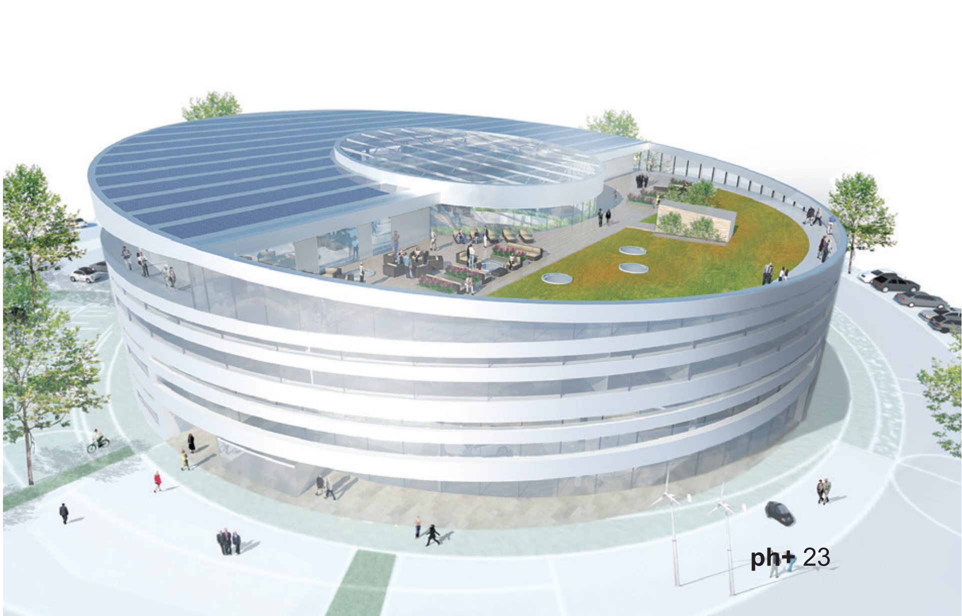
The building's central atrium funnels natural light in, while the exposed concrete slab offers thermal mass that helps smooth out temperatures inside. Air leakage is just 0.1 air changes per hour.

The huge PV array helps to meet the energy demand of the basement data centre — in turn waste heat from this facility is used to provide much of the building's space heating and hot water demand.

"Passive house is all about the overall approach," says Søren Pedersen, director of the Danish certifier Passivhus.dk. "That is why we put the focus on the energy-intensive server system right from the very start."

Pedersen adds: "The thermal insulation is perfect, the glazing is optimal, and airtightness is excellent." ▶

Photos: Syd Energi / Drawing: GPP Arkitekter



Photos: (external): Pol Viladoms / (internal): Rodrigo Diaz-Wichmann

Low Energy MZ House, Barcelona

Is it possible to turn a 90 year old, north-east facing dwelling into a passive house while keeping its original facade? The Low Energy MZ house in Barcelona says, emphatically, yes.

Designed by Calderon-Folch-Sarsanedas architects, what's even more surprising about this 2012 renovation is that it took just four months to complete, and cut the house's space heating demand from 170 to 17 kWh/m²/yr. The project also won an Isover Energy Efficiency Award.

To help re-orientate the tiny 80 square metre dwelling, the architects installed a new skylight that provides both passive solar gain in winter and cross-ventilation in summer — and natural light all year around. A new, glazed timber-frame facade stretches the tiny house out into the garden.

The architects specified a "prefabricated dry construction system" to speed up the retrofit, and the different elements — roof, facade, mezzanine, staircase and skylight — were "designed like Meccano pieces to be manufactured with a numerical control system and afterwards assembled on site". The whole roof was mounted in just a few hours.

The new timber-frame roof and facade are insulated with sheep wool and wood fibre, while other walls in this terraced house are insulated internally with BASF Neopor foam insulation. The house has no mechanical heat source beyond its Zehnder Comfoair heat recovery ventilation system, which captures waste heat from outgoing air and uses it to heat fresh, incoming air. There's also two-and-a-half square metres of solar thermal collectors to help meet hot water demand. Not too shabby for a house built in 1918. ▶

Larixhaus, Catalonia

Words: Oliver Style

The Larixhaus is the first pre-fabricated straw bale passive house built on the Iberian Peninsula. This single family home is located in the town of Collsuspina, near Barcelona.

Developed by Jordi and Itziar in 2013, a pioneering young couple who wanted a comfortable, healthy and low-energy home built from natural and renewable materials, the Larixhaus brings together a team of passive house professionals who delivered it in five months, insulating it with locally sourced straw bales.

The Larixhaus joins a short but growing list of passive house constructions in Spain, where climate-responsive passive design is well suited to the wide varieties of weather conditions, which range from cold and temperate to hot and humid.

The dwelling is small and compact, with an optimised passive design and impressive level of airtightness — it achieved 0.32 air changes per hour on the first blower door test. Windows have timber frames with argon-filled, low-e triple-glazing. The airtight layer is provided by 22m OSB, with timber breather-board behind ventilated larch cladding on the outer skin providing an exit route for any moisture in the building assembly.

Summer comfort is achieved through the careful choice and orientation of opening areas and external blinds on the southern façade. The timber superstructure and external cladding is PEFC certified. Healthy indoor air quality is achieved by using non-toxic natural materials together with heat recovery ventilation. The building's embodied energy and fabric CO_2 emissions are minimised by prioritising the use of natural, non-toxic, renewable building materials (certified timber, locally sourced straw, and cork).

The pre-fabricated construction system developed by the contractor, Farhaus, allows for rapid on-site assembly, pre-installation of the airtight layer and window frames, with associated cost savings and near-zero onsite waste. Future installation of a grid-tied photovoltaic array will bring the building to a net-zero energy balance, with a rainwater catchment system to minimise mains water use.

The Larixhaus puts high-quality straw bale passive house construction firmly on the map, coming in with a final build cost of €1,270 per sqm.

Want to know more?

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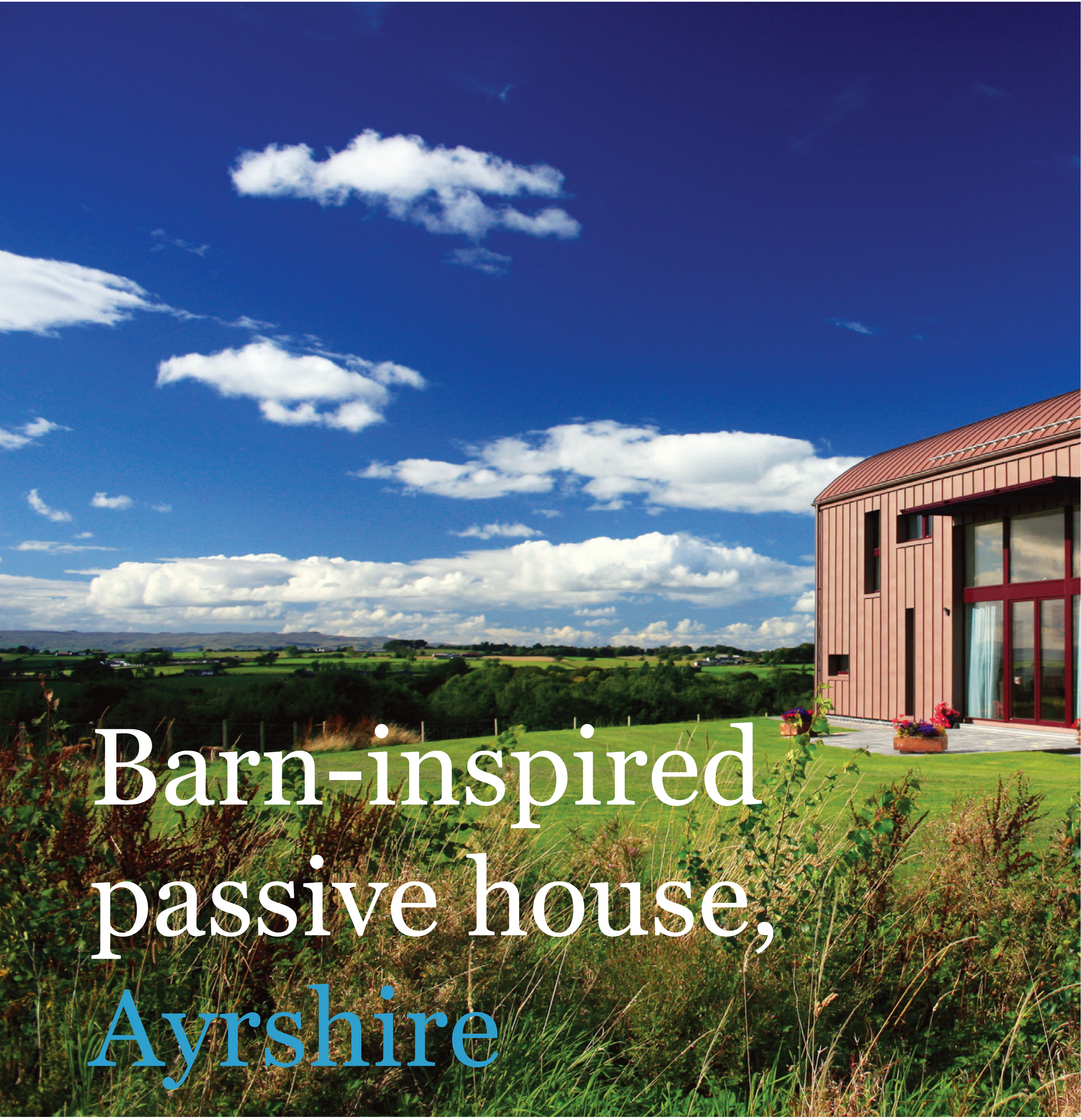

Barn-inspired passive house, Ayrshire

This certified passive house on the west coast of Scotland might look like a traditional hayshed, but it's certainly more energy efficient than one.

Words: Lenny Antonelli

When architect Kirsty Maguire's client in Ayrshire, Scotland invited her to his site, he insisted she come on a sunny day. "And I thought well, I'm used to rain," she says.

But when she arrived, she could understand why — the site has fabulous views extending out to the Isle of Arran.

The client had a strong vision of the type of home he wanted — specifically, a house designed to mimic the traditional rural hayshed.

Kirsty worked on the project through to planning stage with a different architecture practice. The client was drawn to her work there because of a barn-inspired design the firm had developed for a previous project.

"We actually looked at a traditional hayshed on the client's farm and took the proportions from that as a starting point," Kirsty says. The client also travelled around the locality taking photos of other haysheds to inform the plans.

He was keen on an ultra low energy dwelling too, which made for a perfect fit: Kirsty is a certified passive house designer. His desire for a low maintenance home also pushed him towards passive.

Being a small building contractor himself, the client became intimately involved in the technical side of the project. "He's a very knowledgeable client and very enthusiastic," Kirsty says.

Even though planning policy in the area was restrictive, the planners were supportive — and even exhibited the project in a local library. Kirsty also ran a seminar on passive house for the local building control team.

Planning permission was granted, but it took a few years before work began. Kirsty thought her involvement might be over, but when Hope Homes was appointed contractor, her new eponymous firm came on board as project architect. The whole team set out with the explicit goal of reaching the passive house standard.

"What was really nice about the whole project was that it was really a team process with the client as much a part of that team as the contractor, myself and the engineer," she says.

When construction started, her role switched to passive house consultant. Being a contractor, the client looked after a lot of the site inspection himself.

When it came to build method, timber was always the preference. "Timber frame is typical construction culture up here in Scotland. Blockwork is pretty unusual, except as an outer leaf," Kirsty says.

"We spent a lot of time in design trying to make sure things were buildable rather than creating problems for the contractor to solve on site. It was a very exposed site so that was one of the challenges for the contractor."

The I-joist timber frame structure was built on site by Hope Homes. The walls are insulated with 400mm of Superglass 32 mineral wool insulation in two layers (350mm & 50mm), with 9mm OSB and a Pro Clima Intello membrane between. There's a 50mm ventilated cavity on the external side of the build-up, which is clad outside with zinc.

The roof features glulam beams and purlins, with 405mm of Superglass 32 insulation. An Alutrix vapour barrier serves as the airtightness layer here, and the roof is also clad externally with zinc.

Downstairs the ground floor features a strip foundation with lightweight Thermalite block on the internal leaf at slab level to prevent thermal bridging. There's 250mm of Knauf Polyfoam extruded polystyrene insulation under the slab.

Although the site is in the south of Scotland, it's still exposed to tougher conditions than more southern parts of the UK and Ireland, and the building fabric specifications respond accordingly. U-values come in at 0.11 for walls and roof, and 0.125 for the ground floor – levels that the house may not have needed to hit to achieve the passive house standard if transported to more southerly latitudes.

In what some might regard as a brave move, no blower door test was carried out until work on the house finished. But contractor Hope Homes was confident of beating the passive house requirement of 0.6 air changes per hour — their site foreman had acted as airtightness champion throughout the build.

Ecological Building Systems, who supplied the Pro Clima airtightness tapes and membranes, ▶

(Clockwise from above) The roof's curved glulam beams; the airtight layer features the Pro Clima system and an Alutrix vapour barrier; Polyfoam insulation in the sub-floor cavity; Thermalite blocks used to form the cavity's inner leaf; strips of airtight membrane were fitted before the joist hangers were added to preserve the airtight layer.

had also carried out a "toolbox talk" on site. The hard work ended up paying off — the house scored an impressive 0.22 air changes per hour.

Archie Stobbs of Hope Homes says that, having delivered the firm's certified passive house, the company now has a better understanding of the standard. "The project as a whole was interesting from start to finish. Hope Homes certainly gained valuable experience in delivery to the passive house specification."

The house's main heat source are three electric panel radiators and two towel rails. There's also a 2-4kW wood burning stove, though it hasn't been used much so far.

"It's so deep rooted in our culture to have a stove in a rural property that it's difficult for people to move away from that," Kirsty says.

There's also an Ochsner Europa air source heat pump — connected to a 300 litre storage tank — for domestic hot water. The unit – which has a COP of 3.5 based on EN 255-3, assuming an average air-in temperature of 15C and a daily hot water consumption of 150 litres at an average hot water temperature of 52C – was supplied by Glendevon Energy,

and it is integrated with the house's Paul Novus 300 heat recovery ventilation unit.

"We've basically combined the exhaust of the MVHR with the intake of the heat pump," says Stefan Huber of Paul Heat Recovery Scotland — warm stale air extract from the house goes into the intake for the heat pump to boost its efficiency.

Kirsty is keen to monitor the performance of the house in detail, and is hoping to do this in ▶

The site is exposed to tougher conditions than more southern parts of the UK and Ireland, and the building fabric specifications respond accordingly.

conjunction with Strathclyde University.

"Obviously lots of people come together to create a building like this, and everyone including suppliers was really enthusiastic to make it happen," she says. "Really there was a huge can-do attitude from everybody. There are always challenges on any project, but it's really about how those are overcome."

Kirsty went back to visit the house in the autumn to see how her client was getting on. It took a little while for the air source heat pump to work quite as expected, but overall the house was performing as designed — warm, comfortable, and with minimal energy consumption.

She adds: "I asked him would you do anything differently and there wasn't much at all, he had to scratch his head."

SELECTED PROJECT DETAILS
Architect: Kirsty Maguire
Contractor: Hope Homes
Structural engineer: Morgan Associates
Airtightness tester: Jamie Reid
Wall & roof Insulation: Superglass
Floor insulation: Knauf
Airtightness products: Ecological Building Systems
Thermal blocks: Hanson
Windows and doors: Green Building Store
Cladding & roofing: VM Zinc, via HL Metals
Air source heat pump: Glendevon Energy
Ventilation: Paul Heat Recovery Scotland
Wood burning stove: Rika

PROJECT OVERVIEW:

Building type: 165 sqm detached two-storey I-joist timber frame house.

Location: Ayrshire, Scotland.

Completion date: February 2013

Budget: £2300/m² including internal fit out and landscaping.

Passive house certification: certified

Space heating demand (PHPP): 13kWh/m²/yr

Heat load (PHPP): 9 W/m²

Primary energy demand (PHPP): 101 kWh/m²/yr

Airtightness (at 50 Pascals): 0.22 ACH

Energy performance certificate (EPC): C (This figure assumes all heating requirements are provided for by direct electricity because the air source heat pump, which supplies hot water, could not be inputted to SAP. Default thermal bridge values were also used).

Thermal bridging
Zero thermal bridge details used throughout unless unavoidable. Key details were designed very carefully. Including: all corner details (negative details, not modelled and not included in PHPP); window details (modelled in THERM as 0.00); ground floor/slab/found detail (0.00. modelled); eaves detail (Not modelled but designed to be zero). No ridge in the building but all purlins offset to minimise bridging. Windows were the Green Building Store's thermally broken Optwin Alu2Wood windows and detail included over-insulating the frames.

Ground floor: Strip foundation with lightweight Thermalite block on internal leaf. Foundation insulated with 220mm Knauf Polyfoam in cavity. 250mm Knauf Polyfoam under slab with perimeter insulated. U-value: 0.125

Walls: Site built timber frame panels using I-joists. Plasterboard, 350mm insulated services cavity (Superglass 32) Intello Plus Airtightness layer taped, 9mm OSB, 50mm I-joists stuffed with Superglass 32, 9mm OSB, breather membrane, 50mm ventilated cavity, carrier board, VM Zinc standing seam zinc cladding. U-value: 0.11

Roof: Site-built timber frame using glulam beams and purlins. Plasterboard, 50mm services cavity, Alutrix vapour barrier, 9mm OSB, 405mm I-joists stuffed with superglass 32, 2 layers 9mm marine ply, breather membrane, VM Zinc standing seam zinc cladding. U-value: 0.11

Windows: Freisinger-manufactured Optiwin Alu2Wood triple-glazed windows. U-value: 0.84

Heating system: Space heating supplied by 2 x .25kW towel rails and 3 x 0.5kW electric panel radiators plus RIKA Vitra Passivhaus 2-4kW wood burning stove.
Water heating supplied by Ochsner Europa air source heat pump with 300L tank.

Ventilation: Paul Novus 300 MVHR with ISO defroster.

Green materials: Low energy lighting. Insulation with high recycled content. Cladding fully recyclable.

Want to know more?

Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.

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SUSSEX SOCIAL SCHEME

PITS PASSIVE AGAINST THE CODE

In the absence of strong energy requirements under building regulations, much of the UK's new build innovation has been driven by the Code for Sustainable Homes. Amid growing concern that the code's attention to energy efficiency falls some way short of passive house, monitoring results from one social housing scheme offer a rare opportunity for direct comparison.

Words: John Hearne

A development by Horsham housing association, Saxon Weald, breaks new ground by delivering passive housing to social tenants. Standings Court is a home development of 17 houses and 21 flats, 12 of which are passive, while the remaining 26 meet level 5 of the Code for Sustainable Homes.

Marie Riordan of Saxon Weald explains that an earlier housing project the association developed in Billingshurst was the first in the UK to achieve code 5. It was the success of that experience that prompted the association to see if an even better result was possible. "My concern with code was that you can borrow credits from different areas," says Riordan, "so you don't necessarily have to build a particularly good home, you can just whack on a load of technology to achieve the standard, whereas passive house was all about the building envelope, the insulation and airtightness. It just seemed to make more sense in terms of building sustainably."

Standings Court, as one of the first passive social housing developments in the UK, provided a rich training ground for everyone involved. Neither architect MH Architects nor the contractor, Osborne, had built passive before. Energy consultant Warm ran the PHPP calculations and assisted in the design and specification of the build to ensure it made the standard. The company ran workshops with the architects during the feasibility stage, and throughout the design process, architect and energy consultant remained in constant contact.

The site itself lies close to Horsham town centre. The necessity both to retain existing access routes and achieve the right orientation for passive in a terrace form was one of the initial challenges faced by the design team. In addition, there were two existing mature trees which were the subject of tree preservation orders. Architect Nathanael King-Smith says that as it turned out, these constraints didn't actually conflict with each other. "We wanted green areas and we wanted to integrate the two routes into town with the new scheme, together with the orientation for passive house. It all fell into place and worked quite nicely. It could have been a lot harder on a different site."

Getting around these physical constraints was one thing, actually achieving a pleasing design was another. "We wanted to design something that wasn't just a box," says King-Smith. "The design needed to be interesting, and interesting to live in. That was the challenge."

Compromises were inevitable. The original design sought bay-windows, but the window profiles were so 'chunky' that they could not achieve the effect that the architect had hoped for, and so the bay windows were dropped. To avoid a flat and featureless façade, terraces were introduced to the northern elevations of the passive block while the bathrooms of these units protrude at ground floor level. These features required very careful detailing in order to ensure they didn't compromise the thermal performance of the building envelope.

Mark Wellbelove of contractors Osborne says that the company had well established processes for conventional building projects. But Standings Court required a reinvention of those processes. "Our close communication with Warm throughout the design period meant that we learned along the way...Understanding the passive house was one of the biggest hurdles."

Structurally insulated panels (SIPs) were chosen as the build method. These were manufactured by a sister company of Osborne's, Innovaré. On a field trip prior to his involvement in Standings Court, Wellbelove had seen OSB panels used as an airtight layer in a passive build. Because OSB panels were also being used in the SIPs under construction at Innovaré, it seemed a natural fit. Innovaré went on to develop a product specific to the passive house building envelope requirements.

Throughout the project, a system of checks, controls and sign-offs ensured compliance with all of the client's requirements. During the build itself, the contractors produced a monthly validation report, complete with photographs and commentary, where any problems were highlighted, along with any remedial measures taken.

Knowing airtightness was going to be a big issue, the design and build teams went to great lengths to ensure that the passive units met the targets. Marie Riordan explains that the contractors ran 'toolbox talks' onsite, in which the importance of the airtight layer was emphasised. "They explained, this is what you have to do, this is why you have to do it...If you do puncture through, tell somebody straight away. It was all about reinforcing those principles all the way through, a top down, bottom up approach."

In some instances, problems did arise however when repeated tests failed to get the air leakage rate below one air change per hour, well short of the passive house requirement of 0.6. In particular, anxiety began to centre on the use of OSB as an airtight layer. "Some units passed with an OSB airtightness layer," says Mark Wellbelove, "but with others we ended up having to put membranes onto the wall before we plasterboarded." Ultimately, that attention to detail paid off and all of the units passed at or below the passive house threshold. "Once two or three guys were assigned to air leakage," says Wellbelove, "they took on board the importance of it and why we're doing it – they became quite passionate about it. That was great to see."

One issue that has tended to arise with social housing tenants - and indeed any people occupying sustainable buildings by chance rather than design - is a failure to engage with the building's M&E systems. Marie Riordan says that at Saxon Weald's code 5 development in Billingshurst, induction sessions were provided to help tenants familiarise them with the underfloor heating and ground source heat pump that were installed in the project. "What we found was that wasn't enough for most people...So what Osborne and the project manager for Standings Court did was put together a DVD, and uploaded a video about the home to YouTube."

This, she says, has yielded mixed results. Some tenants have had particular trouble grasping the concept of mechanical heat recovery ventilation and the necessity to run it constantly. "Even when you try to demonstrate how little it costs, there's still some anxiety because it's new and they haven't had to deal with it before. Similarly with the requirement to clean the filters. It's no different to cleaning out the filters in your cooker hood, but not everyone does that."

Immediately after construction, two of the passive houses together with a selection of the code 5 units were fitted with a range of monitoring equipment designed to assess their performance. Once a year's worth of data had been collected, consultants SRE Ltd produced a report which contained a number of surprising results.

The two passive house units monitored used respectively 27% and 38% of the gas for hot ▶

(above, clockwise from top left) the strip foundations; (top right) Intello membranes for added airtightness; taping of the purlin pockets on gable wall panels; airtight membrane applied to the floor cassette zone; the development includes passive (below & pp34-35) and code 5 (p39) dwellings.

water and space heating that had been predicted by PHPP. In addition, taken on a per-occupant basis, the passive house units used respectively 68.9% and 77% less gas over the year than the code 5 units. While the design team was gratified by the performance, it begs the question why the software was so inaccurate in its predictions.

The other key finding is that summer overheating is occurring on a regular basis in the passive units. In the two units monitored, the daily internal temperature exceeded 25C for 13.7% and 14.8% of the year respectively. One unit experienced a 15 hour period during which internal temperatures exceeded 30C.

John Trinick at Warm says that the reason for both the low gas consumption and the overheating is likely to be occupancy. "The biggest thing we are learning from monitoring social housing passive units is that the occupancy and the amount of time people are there doesn't exactly match the passive house assumptions. The reality is that you have much higher internal gains. Instead of having 15 kWh/m²/yr of heating like we predict, you have almost zero, and you have a bit more overheating than you ▶

"The two passive house units monitored used respectively 27% and 38% of the gas that had been predicted"


Local Focus
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would have predicted."

Trinick is careful not to overstate the overheating issue. "We're finding overheating issues with passive house but it's not necessarily because they're passive house. A lot of it is because we're looking. My house gets to 28C on hot days and it's not a passive house, in fact it's got almost no insulation whatsoever. But it's badly designed. Overheating is a design issue...If you design a house without regard to overheating, you'll cook, that's true. It's not a specific passive house issue."

He says that the passive house community in the UK needs to look at designing for all kinds of different occupancies. Warm's subsequent passive projects have built on the experience of Standings Court, adapting passive house modelling to take account of these lessons, particularly in a social housing context.

Likewise, the rest of the design and build team has capitalised on their experience in Horsham. "What we're concentrating on doing now," says Mark Wellbelove of Osborne, "is taking as many of those lessons we learned through Standings Court, taking them onto other schemes and applying that little bit of information to improve the quality of the build."

SELECTED PROJECT DETAILS
Client: Saxon Weald Housing
Architect: MH Architects
M & E engineer: Derek Durant Associates
Civil / structural engineer: GEMMA Building and Design Services
Energy consultant: Brooks Devlin & Warm
Main contractor: Geoffrey Osborne Ltd
Quantity surveyors: Phillip Pank Partnership
Mechanical contractor: Nuaire Limited
Build system supplier: Innovaré Systems
Floor insulation: Cellecta
Windows and doors: NorDan UK Ltd
Roof lights: Fakro GB Ltd
Heat recovery ventilation systems: Zehnder
Condesing boilers: Vaillant
Photovoltaic supplier: Ecolution
Flooring: Charcon Flooring
Roofing: Boss Metals

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PROJECT OVERVIEW:

Development type: 38 home development - 17 houses and 21 flats, 6 designed for people with learning difficulties. Ranging from 87 sqm 3-bed two-storey houses to 112 sqm 4-bed three-storey houses, with flats sized between 49 to 69 sqm. The code 5 houses are constructed using SIPs and timber frames, the passive houses are 3 and 4-bed homes between 101 and 111 sqm constructed using SIPs.

Location: Standings Court, Horsham, Sussex

Completion date: April 2012

Budget: £4.5 Million

Passive house certification: certified

Space heating demand (PHPP): 15 kWh/m²/yr

Heat load (PHPP): 10 W/m²

Primary energy demand (PHPP): 111 kWh/m²/yr

Environmental assessment method: Code for Sustainable Homes – level 4 for passive houses and level 5 for flats and remaining 5 houses

Airtightness (at 50 Pascals): 0.6 ACH or better

Energy performance certificate (EPC): B: 89

Measured energy consumption: 60.3 kWh/m²/yr (Sep 2012-Sep 2013) average across two passive homes monitored.

Thermal bridging: A logical approach was taken to designing and detailing each component to minimise heat loss. At each stage of the design process thermal modelling was performed by the consultants, Warm Associates, to identify problem areas and further iterations of the detailed design performed until acceptable results were obtained. Key examples include:

The structural frame within the SIPs panels
The standard SIPs panel uses solid timber frames, relying on the relatively good thermal properties of timber. When modelled these solid timber elements were completely unsuitable for use in passive construction and the frames were redesigned using smaller sections of timber and plywood webs forming a box section filled with insulation.

Fastenings connecting the SIPs panels
Usually connected using long 'spikes' driven from outside into the adjacent component. These provide a thermal bridge which would be unacceptable in passive construction. An alternative solution was devised using nails secured to a specially fabricated mandrel which was removed once the nail was in place. The resultant counter-bore was filled with insulation.

Also thermally broken window frames and insulated reveals, additional insulation on the internal side of the SIPS panel.

Ground floor: strip foundations with 175mm insulation between and under Tetris Eco Block floor system and 150mm insulation and 65mm screed over. U-Value 0.10

Walls: Brick course, 50mm cavity, breather membrane, factory-built 297mm SIPs panel, 25mm insulated service cavity, and 15mm plasterboard internally. U-value: 0.10

Roof: Falzonal zinc standing seam roofing on breather membrane on 18mm plywood decking with 50mm ventilation void, followed by 297mm thick SIPs panel on VCL and 100mm internal insulation then 25mm insulated services cavity , 15mm plasterboard ceiling. U-value: 0.08

Windows: NorDan Ntech Passive triple-glazed composite windows with argon filling and an overall U-Value of 0.7. Fakro FTT Thermo triple-glazed roof lights 0.94

Heating system: Vaillant Ecotec Plus 824 (89.4%) gas boiler supplying radiators to all rooms, plus solar hot water panels supplying separate domestic hot water tank

Ventilation: Zehnder Comfosystems CA200 with 92% efficient heat recovery

Electricity: N/A to the passive house units

Green materials: Offsite manufacuter of SIPs allows optimum amounts of material to be used, with all wood FSC certified. All principal elements achieved an A+ rating in the Green Guide to Specification, with the exception of the triple-glazed windows which feature PEFC certified timber and were given a bespoke rating of B by the BRE.

Mallow build hits passive on a budget

Exploding the myth that passive house means unfamiliar construction methods and considerable expense, one Cork-based builder has gone passive using wide cavity wall construction – for a competitive cost of €100 per sq ft.

Words: John Hearne

Larry O'Donoghue's new as yet uncertified passive house in Castlemagner, near Mallow in Co Cork, is a neat example of how traditional building methods can be adapted to produce a house which meets all of the passive criteria. O'Donoghue runs building firm, Magner Homes with his brother Ed. "Our tagline as a company is passive and energy efficient home builders. You have to believe in the concept yourself, so when it came to building my own house, I had to go passive."

After a career building houses for other people, O'Donoghue also had a clear idea about what he wanted to build and how he wanted to build it. "I went concrete for a bunch of reasons that had nothing to do with passive. I wanted a concrete first floor in my house, to prevent inter-floor sound transfer. One thing that really bugs me in two-storey houses is hearing the pitter-patter of feet upstairs."

He notes too that despite the rise of timber framed housing in the last decade, more than 80% of the houses that Magner builds, all of which are low energy, are of masonry construction. Old habits, it seems, are not dying at all.

Masonry passive houses tend to take one of two approaches. Either a combination of block on the flat with external wall insulation, or else a super-wide cavity and full fill insulation. O'Donoghue opted for the latter.

Fully aware of the orientation, layout and design principles that inform passive house – no matter which build method is used – O'Donoghue opted for a relatively simple footprint. The site itself was quite challenging, in that it's long

Photos: Fiona Fuller

and narrow, and oriented north-south, making it a little more difficult to optimise glazing. Before going for planning, O'Donoghue ran his design through PHPP, the passive house software. "You use PHPP as a proofing tool really. You might be aware of the dos and don'ts of passive design, but you don't know the results until you put it through PHPP...In this case, I managed to hit the sweet spot between solar gain and heat loss."

Cavity wall construction has of course been a staple of Irish building practise for many years. The twist here is that the cavity is 300mm wide, allowing sufficient room for the insulation required to deliver a passive performance. That twist however throws up a number of engineering issues that also have to be addressed.

Tim Lenihan was the structural engineer on the project. He points out that with a cavity that wide, you can't use conventional wall ties. Not alone will they fail to bridge the gap, they will also conduct heat out of the structure. Ancon TeploTie 2 basalt wall ties were specified instead, while in place of the standard cavity closer, a double wall plate was installed.

Larry's brother Ed is in charge of technical specifications in Magner. He welcomes the fact that the form of construction chosen for the build relies on a local, well-established skill base. He points out however that those skills require a number of subtle tweaks in order to deliver a successful passive project. "Take the TeploTies," he says. "They're great, you get full documentation on the centres needed and the installation instructions and all the rest. So you have great confidence from the information on the cert to go ahead and do the work, but ironically, everyone that saw them was worried about whether they were going to work because they're such an unusual material."

The absence of a cavity closer also made some of the tradesmen on site slightly uneasy. Its removal however allows the creation of an unbroken insulated envelope. "The beauty of this type of house," says Ed O'Donoghue, "is that it's just an enhancement of a very common detail. It just takes people a while to become comfortable with those enhancements."

Because the main structure is a simple rectangle, structural issues within the house were kept to a minimum. Moreover, the spans were short enough to reduce the need for structural walls internally. Wherever possible, timber studwork was used instead.

Quinn Lite blocks, underlaid with damp proof membrane, were used in the rising walls. "Any walls that were non-structural," Ed O'Donoghue explains, "were not based on top of a foundation strip. Instead, we put a structural high density insulation beneath the footings of those walls and the insulation was strong enough to take the weight of the wall." The floor slab was thickened slightly in these locations, but they remained thermally isolated. "You have to be careful about these things. You have to make sure that the structural engineering calculations can sustain the details that you're trying to achieve."

As is frequently the case, the central challenge of the build was achieving airtightness. While a wet plaster finish was a fundamental element of the airtightness strategy, several other details were also critical. Larry O'Donoghue says that careful planning from an early stage is vital. All services and ducts are detailed on the construction drawings in order to ensure that there is no need to break out walls at a later stage. Designed service cavities are used in order to remove the need for chasing blockwork and installing electrical conduits down the walls. "I would say without that it's pretty much ▶

So far electricity bills for ventilation & heating have been averaging between €17 & €20.

impossible to hit the airtightness standard," he says.

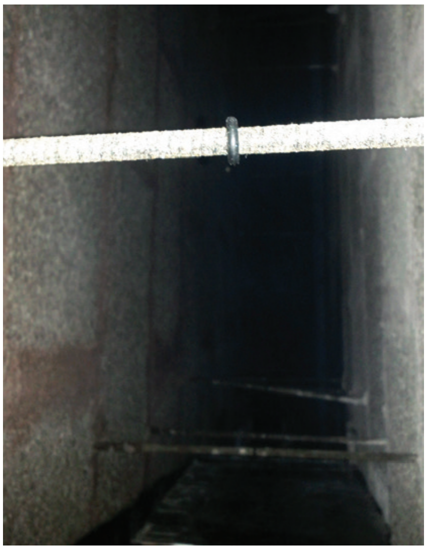
Tim Horgan of Passive House Design in Killarney provided energy consultancy on the build. His work centred on establishing the heating load for the system that O'Donoghue planned to install. Local climate data is a key input into these calculations, and in Ireland, the default data typically used is taken from either Birr, Co Offaly or Dublin. But because this house is located in Cork, Horgan also ran the calculations using a set of climate data taken in Killarney. This data isn't normally available in the PHPP software — he acquired it from John Morehead of Wain Morehead Architects. The rationale behind running this set of calculations lies simply in the fact that because the southern climate is more benign, the space heating load will be reduced.

The differences were not sufficient to impact the choice of heating system in this instance, says Horgan. But he points out that if a build project was on the cusp of the passive house criteria, local climactic conditions, even within Ireland, could make a significant difference. "The space heating demand is 3 kWh/m^2/yr better with Killarney data...So if you were struggling to meet the passive house target [15 kWh/m^2/yr] it's definitely worth getting a climate data set for your particular site, if of course you live on the coast or down south."

The primary heating system is a Nilan Compact P unit, which integrates an air-to-air heat pump with a heat recovery ventilation system complete with a 2kW in-duct booster heater, and uses exhaust air to heat up domestic hot water. Maurice Falvey of Nilan Ireland suggested to O'Donoghue that he also incorporate a cooling component into the system. This proved very helpful during the summer, effectively allowing O'Donoghue to run the system in reverse — heat extracted from the incoming summer air is used to produce domestic hot water, in the process cooling down fresh air that is introduced into the house.

"I set the target temperature at 22C," says O'Donoghue, "but it probably did slip up to 24C in the middle of the day, whereas I know houses that didn't have that active cooling system, and went up to 29 or 30C."

He has been keeping a close eye on his energy spend since moving in nine months ago. So far electricity bills for ventilation and heating have been averaging between €17 and €20. The backup heating system, an Extraflame Duchesa wood chip pellet stove with back boiler – which feeds five radiators throughout the house – has, in O'Donoghue's words, been no more than an 'ornament' in the house. ▶



On the subject of build cost, he has this to say. “For a standard A-rated build, you’re looking at €80 or €90 a square foot. If you were to take that same building and make it passive, you’re looking at between €90 and €100 a square foot. There could be little or no difference, or there could be quite a difference depending on the design of the house.”

SELECTED PROJECT DETAILS
Client: Larry O’Donoghue
Architect (design & planning): Feargal Sheahan
Civil & structural engineering:
TGL Consulting Engineers
Energy consultant: Passive House Design
Contractor: Magner Homes
Mechanical contractor:
Kevin O’Donoghue Plumbing & Heating Services
Electrical contractor: A&J Electrical
Airtightness installer: Magner Seal
Airtightness tester: Collins Energy Consultants
Cavity wall insulation: Envirobead
Cellulose insulation: Warmcel
Floor insulation: Kingspan
Airtightness products:
Siga, via McMahon Building Suppliers
Windows and doors: Munster Joinery
Air source heat pump & ventilation: Nilan
Wood pellet stove: Kerry Biofuels

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PROJECT OVERVIEW:

Building type: 270 sqm detached two storey masonry house

Location: 1 Magner Avenue, Churchfield, Castlemagner, Mallow, Co Cork

Completion date: May 2013

Budget: €270,000 (including finishes)

Passive house certification: pending

Space heating demand (PHPP): 14 kWh/m²/yr

Heat load (PHPP): 9 W/m²

Primary energy demand (PHPP): 74 kWh/m²/yr

Airtightness: 0.54 ACH at 50 Pa

BER: 52.83 kWh/m²/yr

Thermal bridging: Last two courses of deadwork are Quinn Lite blocks, 50mm edge insulation strips, no internal partition foundations (stud work only), low thermal conductivity cavity wall ties – Ancon TeploTie 2, thermally broken window frames – Ecotherm Plus Passiv certified windows and doors, insulated reveals (no cavity closing blocks, no wallplate closing blocks, door threshold bridging detailing. Y-value (based on ACDs and numerical simulations): 0.08 W/mK

Ground floor: Standard strip foundation using Quinn Lite thermal blocks in the last 2 rows of deadwork, 50mm edge insulation strips, 200mm Kingspan Thermafloor insulation: U-value: 0.112

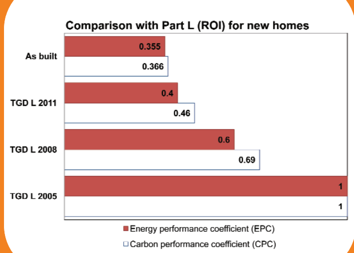
Walls: 100mm external block, 300mm cavity using Ancon TeploTie 2 basalt wall ties, 100mm inner block, hard coat and skim finish. U-value: 0.106

Roof: Cupa H5 Natural slates externally on 50x35 battens/counter battens, followed underneath by breathable roofing underlay, 450mm cellulose on flat of attic: U-value: 0.096

Windows: Passive House Institute certified Munster Joinery Ecotherm Plus Passiv windows, with PVC frame and aluminium cladding internally and externally. Subject to window size, U-values range from 0.47 to 0.78

Heating system: Nilan Compact P air to air heat pump combining heat recovery ventilation, 2 KW in duct booster heat element, active cooling module, 180 litre domestic hot water tank. Secondary heating system is an Extraflame Duchesa wood chip pellet stove with back boiler feeding 5 radiators throughout the house.

Ventilation: Nilan Compact P air to air heat pump combining heat recovery ventilation, 2 KW in duct booster heat element, active cooling module, 180 litre domestic hot water tank



(above) Siga tapes and Intello membranes help to ensure the house is airtight, one of the main objectives in the build; (p43, top to bottom) thermal bridging strategies included the omission of a cavity closer; TeploTie basalt wall ties; and insulated window reveals.

Laois self-builder goes hands-on to hit passive

In spite of having no construction experience Steve O'Rourke decided to make his self-build home a passive house, a feat achieved by a well-considered and collaborative approach.

Words: John Hearne

Steve O'Rourke's passive self-build in Co Laois didn't start out passive. In fact, it didn't even start out low energy.

"We got a house drawn up that was your typical sprawling boom-time elaborate design," he says. "I knew nothing about energy efficiency, I knew nothing about passive house." He began building in October 2009 and got as far as the rising walls before a change in personal circumstances meant that the project had to go on hold.

It was while he was away from the site that he began to rethink the entire build. The passive house concept had begun to gain ground in Ireland. Moreover, O'Rourke wanted a big house – in excess of 3,000 square feet. When he realised that running a house that size would generate huge energy bills, he re-applied for planning permission for a more energy efficient building, while reusing the footings that had already been put in place. In a bizarre twist of fate however, planning failed because on the day the planners visited, the site notice had fallen down.

"So here was another delay, and at that stage myself and my wife Suzanne came to the conclusion after many months of debate that we would go back to first principles and design a passive house." This was a tough decision to make, not least because it meant demolishing the footings they had already put in place. "The way I looked at it was, we had invested ten grand. Am I going to make a decision on a house that we will live in for the rest of our lives for the sake of ten grand? Plus we were fortunate enough to be in a position where that wasn't the end of the world for us."

Instead of relying exclusively on professional advice, O'Rourke went online, and on both boards.ie and this magazine's predecessor constructireland.ie, he drew substantially on the experiences of other passive house enthusiasts, in particular a Donegal-based self-builder. "He was six to twelve months ahead of me on an identical spec build. We went with the same foundation system and the same wall build up. We went in different directions on the roof but I was able to learn from his mistakes and he was great to share with me."

He also got in touch with the Passive House Institute in Germany and negotiated a deal for full PHPP (the passive house design software) modelling, guidance on detailing and certification. Detailing junctions to ensure the absence of thermal breaks is vital in passive house design. The approach the Passive House Institute took with O'Rourke involved reviewing the details he supplied and either approving them or declaring the detail thermally weak and instructing him to come up with something better.

Though he had no construction experience, O'Rourke actually ended up drawing up many of the details himself. He points out that at the time in Ireland, it was difficult to find someone to model the junctions at reasonable cost. The house itself, while large, is a relatively simple L-shaped design. The combination of block-on-the-flat with external wall insulation – a Sto system featuring 300mm of EPS insulation adhesively fixed to avoid thermal bridging from mechanical fixings – together with an Isoquick insulated raft also helped by creating a continuous external insulation layer which automatically did away with many of the thermal bridges that would otherwise arise.

"I didn't have any complex junctions, I didn't try mounting a balcony through the external insulation to the masonry, I didn't have to worry about thermally broken steel fittings...There's polystyrene underneath the house and straight up to the roof the whole way around. So apart from a couple of soil pipes that go through the floor, and ducts for wiring, that was pretty much it."

O'Rourke had a unique approach to hiring tradesmen. "Anyone I engaged with, I explained what I was trying to do. Then you let them get over the initial shock. I would say, 'I'm not asking you to believe. There will be details which you will be unfamiliar with. If they contravene building regulations, speak up, if they're going to set the house on fire, if they're structurally questionable, again, speak up. If they're just different, but there's nothing wrong with them, you have to accept this and move on. If you're happy to work with me on this basis, you can work with me, if we can agree a price, and if you're not, thanks for your time.'"

O'Rourke also set great store by actually liking the people he worked with. The atmosphere he created onsite encouraged everyone involved to report problems and mistakes as they happened, rather than burying them in the hope that they would not be noticed.

While he ran the project himself, he also relied heavily on carpenter Bryan MacNamara. Together, he and O'Rourke worked through most aspects of the build alone. In addition to relying on testimony from web forums, he also had support from Archie O'Donnell of Integrated Energy.

O'Rourke considered both masonry and timber frame construction, opting eventually for the former, primarily for cost reasons. The building required a rendered finish and at the time, the only cladding product which he considered suitable carried a price tag of €40,000. This alone made the timber frame option – which he would have favoured otherwise – prohibitively expensive.

Achieving an airtightness result of 0.6 air changes per hour or lower was of course one of the central challenges of the project, and one which O'Rourke was particularly focused on. In driving for that standard, he was heavily supported by Roman Syzpura in Clioma House, and by the experts at Ecological Building Systems, while Damien Hogan directed the installation of the airtightness membrane on the ground.

"Looking back, it wasn't that hard, it was more about discipline with your trades," he says. O'Rourke made sure he was present for all critical stages, including the installation of the hollowcore ceiling on the ground floor. Prior to the arrival of the floor, which was to be craned into place, O'Rourke's blocklayer laid a protective layer of mortar all along the top of the wall over the airtightness membrane. He also instructed the hollowcore company that they could not crowbar the slabs into place. It was crucial that they be dropped into their final position from overhead in order to avoid dragging across the top of the membrane. "They did exactly what they were asked to do, and again it worked out. The membrane didn't leak and that's a notorious spot for leaks."

O'Rourke also oversaw the construction of a ring beam at ceiling level on the first floor. While the beam is structural, it was specified primarily as an airtightness detail. "The idea is that mass concrete is pretty much airtight. That ring beam is exposed about four inches below ceiling level upstairs and it extends up about twelve inches above ceiling level, so my joists are fixed to that concrete, and downstairs we plastered up over that concrete."

This approach meant that there was no necessity to tape the airtightness membrane around the floor joists. The downstairs plaster simply overlaps the airtight concrete.

a simple test: he lit the stove and blocked the external air supply. "The fire went out," he says.

As the project progressed, O'Rourke admits to becoming increasingly focused on details. "I became entirely lost in the build process...I lost track of the need to keep the thing moving. I spent weeks worrying, visiting and revisiting before I would make the call." He even considered ripping out electrical sockets to try and improve what was a hugely impressive airtightness result, simply because he knew it could be done. "I said to myself, that was a first attempt, we can do better. My friend in Donegal talked me out of it. He said, 'You hit your results,

Though he had no construction experience, O'Rourke actually ended up drawing up many of the details himself.

In the run up to the blower door test, O'Rourke sent out invitations to the self build community he'd been corresponding with online. "I said I'd love you to come along and see my moment of victory or failure." The first and only test delivered a result of 0.32 air changes per hour, which amounts to a tremendous victory for a first-time self-builder with zero construction experience.

Attention to airtightness also extended to the Stuv Cube 16/78H, a wood-burning stove adapted for airtight buildings, supplied by Murphy Heating, and fitted with an outside air inlet directly beneath the stove. To ensure that the stove was genuinely room sealed, O'Rourke conducted

move on, you're talking about saving yourself a couple of euro a year extra if you improve it, but you could spend a grand getting there.'"

Steve and Suzanne O'Rourke eventually moved in in May 2012. The house, they report, has delivered on all of their expectations. "We had a party in the house last night, and people were asking, what heating system have you in? I told them that there was an underfloor heating circuit downstairs, but that we hadn't switched it on since November 2012."

So it was worth it? "I would do it again in the morning." ▶

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SELECTED PROJECT DETAILS

Client: Steve and Suzanne O'Rourke
Architect: Liam Ryan Architectural Services
Civil / structural engineer: Luke Hyland
Energy consultant: Liam Ryan Architectural Services
Energy consultant: Integrated Energy
PHPP consultancy: Passive House Institute
Carpenter: Bryan MacNamara
Electrical contractor: David Whelan
Airtightness tester/consultant: GreenBuild
External insulation system: Sto
External insulation applicator: HR Plastering
Roof insulation & airtightness installer: Clioma House
Additional roof insulation & airtightness products: Ecological Building Systems
Floor insulation: IsoQuick
Windows and doors: Pazen Ireland
Screeds: Hanlon Concrete
Stove: Murphy Heating
Solar thermal: Kingspan Solar
Radiator supplier: PJ Nolan Heating and Plumbing
Underfloor heating: Wavin
Heat recovery ventilation: Paul Heat Recovery Scotland
Sanitaryware: PJ Nolan Heating and Plumbing
Carpets: Centre Point Carpets
Roofing: Lagan

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PROJECT OVERVIEW:

Building type: 300 sqm detached two-storey externally insulated block built house

Location: Laois

Completion date: Not sure, move in date was 4 May 2012

Budget: Not disclosed

Passive house certification: pending – some final detailing to be accounted for

Space heating demand (PHPP): 9 kWh/m²/yr

Heat load (PHPP): 7 W/m²

Primary energy demand (PHPP): 70 kWh/m²/yr

Airtightness: 0.32 ACH

Building Energy Rating (BER): A2 (32.83 kWh/m²/yr)

Thermal bridging: Based on prescribed and precalculated values from the Passive House Institute

Ground floor: Isoquick insulated raft foundation with 250mm EPS insulation. U-value: 0.12

Walls: external render on 300mm adhesively fixed EPS external insulation, 215mm dense block on single leaf, scud coat, scratch coat and gypsum plaster finish. U-value 0.11

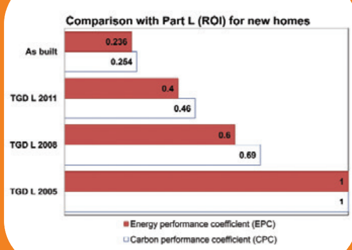
Roof: natural slate externally on 50x25 battens/counter battens, followed underneath by Solitex plus breathable roofing felt with joints taped for wind tightness, 270mm joists fully filled with cellulose, Intello airtightness membrane followed by 25mm uninsulated service cavity. U-value: 0.14

Windows: Pazen Premium Maxi triple-glazed aluminium-clad eucalyptus windows, with argon filling and an overall U-value of 0.77

Heating system: 97% efficient Grant Vortex condensing oil boiler supplying 1000 litre combined buffer and domestic hot water tank, plus 90 Kingspan solar HP200 vacuum tubes and Stuv 16-H room heating stove with external air supply.

Ventilation: Paul Novus 450 heat recovery ventilation system — Passive House Institute certified to have heat recovery rate of 89%

Green materials: Gutex softboard, cellulose insulation, all timber furniture from PEFC certified sources



(top left) The roof build-up features an Intello membrane (middle left) the Sto external wall insulation features 300mm of EPS adhesively fixed to avoid thermal bridging; (bottom left) the house is rendered with a Gypsum plaster finish; (p47, clockwise from top) the Isoquick insulated raft foundation; the original footings were removed once the O'Rourkes decided to go passive; a ring beam forms part of the airtight layer; the hollow core contractors laid slabs on the airtight membrane to avoid punctures.

Victorian upgrade hits 80% energy saving

Most energy upgrades to historic homes in architectural conservation zones take a fairly gentle approach to insulation and airtightness — this one did the exact opposite.

Words: Lenny Antonelli

For an architect designing the energy retrofit of a Victorian home, who better to have as a client than a building physicist?

Robert Prewett of Prewett Bizley oversaw this east London upgrade for homeowner Robert Cohen, who has a doctorate in energy conservation.

In 2008, Robert and his partner Bronwen bought a run-down house in Hackney with the intention of upgrading. The dwelling sits in an architectural conservation area, so any upgrade would have to tread lightly on its character.

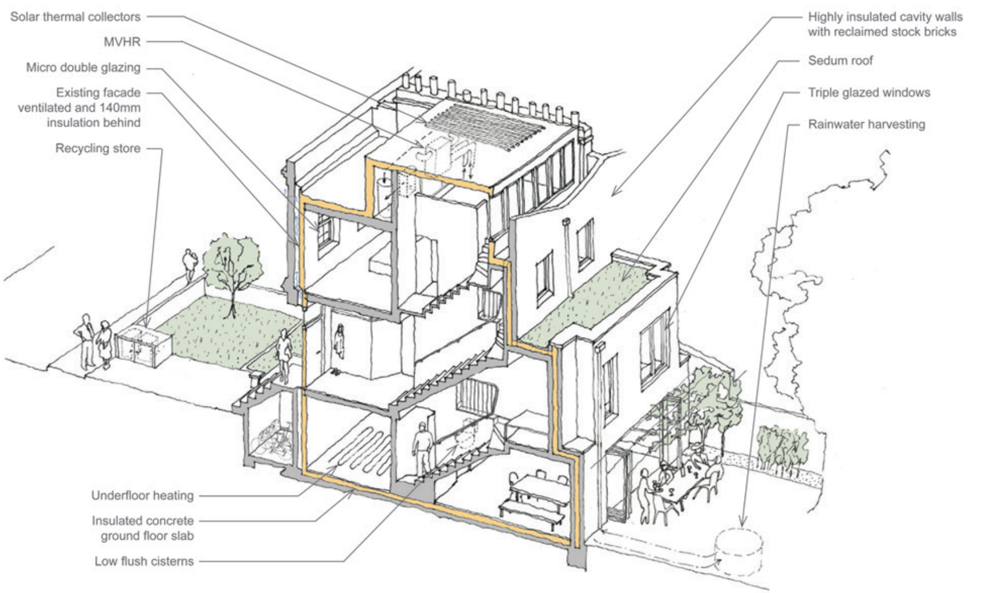
"We were initially thinking we would do the conventional energy efficiency upgrade, relatively modest," says Cohen.

But the couple and their architect studied the options, and developed a more radical plan — a deep energy retrofit that would require gutting much of the house.

Prewett was consciously avoiding small extension projects at the time, but couldn't resist taking on an ambitious energy upgrade.

"Until the project was complete Enerphit didn't even exist," he says. "But I think there was implicitly the aim of: how far is it possible to go?"

"In some ways it was probably a bit naive, but ▶



Photos: Kilian O'Sullivan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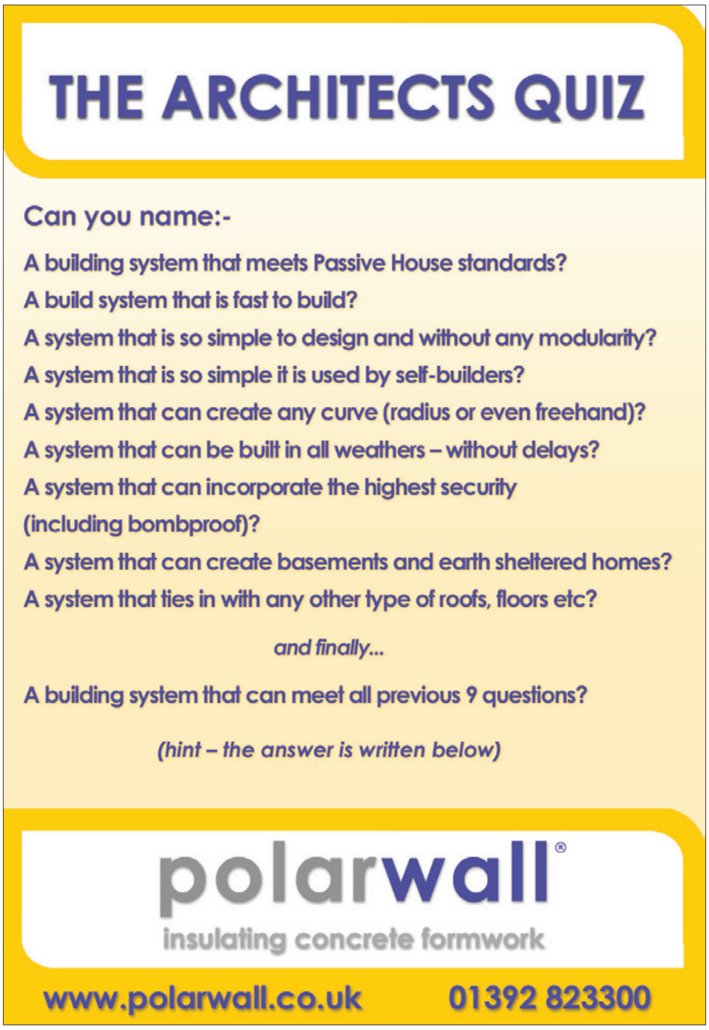
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(including bombproof)?
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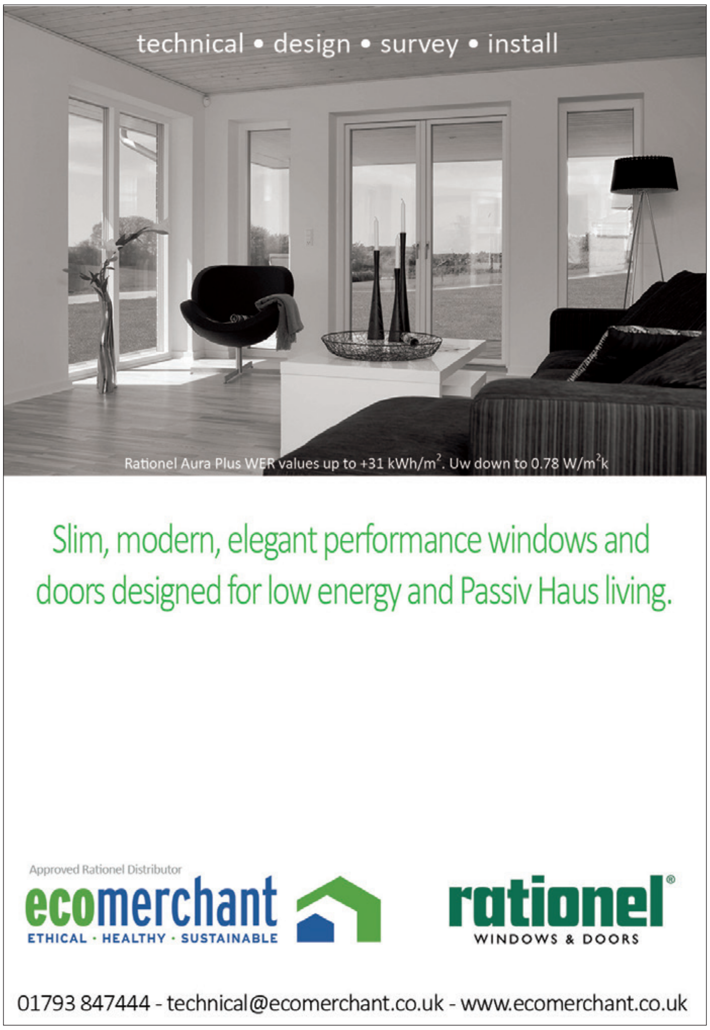
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(p51) The front windows are of bespoke joinery with slim double-glazing, chosen to maintain the house's traditional facade; (above) the new rear facade features timber-framed windows with triple-glazing; (p55, clockwise from top left) the windows are suspended within the cavity wall insulation to avoid thermal bridging; the existing joists were cut back and attached to a steel beam connected to the party walls to reduce cold bridging.

sometimes a bit of naivety is probably good."

Convincing the planners to approve the project took over a year. "They were very nervous about the invasiveness of our approach, because we ended up stripping out most of the house interior and rebuilding it," says homeowner Cohen.

Personnel in the planning office kept changing, which slowed things down further, and it took a last minute meeting with a senior planning official to keep the project on track.

"It went through at the last moment. It was quite a strange sequence of events, because up until that meeting we really did think we were going to be refused," Cohen adds.

He says passive house principles guided the design — though he knows the very term can be controversial.

"There is a sort of feeling in the UK, if not further afield, that people who say they're designing to passive house principles are not doing passive house properly, and they try to shout you down."

But in this case, it accurately reflects their approach. "We were trying to do passive house properly, but we had constraints."

The team removed the rear facade and built a new cavity wall system in its place: brick externally, a 200mm cavity insulated with Knauf Dritherm 32, and lightweight concrete block inside. Low thermal conductivity TeploTie wall ties, and Foamglas Perinsul blocks at the junction between inner leaf and floor, cut out thermal bridging. Foamglas Perinsul is a low thermal conductivity structural block made largely from recycled glass.

The team insulated the front wall with Knauf's Thermoshell internal wall insulation system, which employs polystyrene-OSB composite studs to minimise thermal bridging, meaning less insulation is needed and less floor space is used. Here there's two layers of studwork — one vertical, one horizontal — insulated with Knauf Earthwool. A ventilated cavity just inside the existing masonry will help the structure dry out should any moisture accumulate here. The party walls are insulated too, partly in case the neighbouring houses are ever unheated, partly to provide an acoustic barrier.

Downstairs, the team insulated the ground floor with Knauf Eco Floorboard, a rigid insulation board made of extruded polystyrene (XPS).

The front windows are of bespoke joinery with slim double-glazing, chosen to maintain the house's traditional facade.

"Those windows contribute a lot to the heat loss of the house unfortunately," Prewett says. But he adds: "I think on this one we struck the balance between conservation of history and conservation of the planet probably as best we could with the technology we had."

The new rear facade features timber-framed triple glazing, supplied by Double Good windows. The windows are suspended within the cavity wall insulation to avoid thermal bridging.

The team completely overhauled the house's internal layout. At the lower and upper-ground floor, the rear wall was built further out to extend the living space, and its flat roof is topped with a mat of sphagnum moss, while the old dog-leg staircase was replaced with a straight flight. Prewett says these two changes opened up the house substantially. Upstairs, a bedroom-cum-study was built into the attic — an external Mermet blind was fitted on the west facade here to control glare and overheating. A new flat roof on the attic space was constructed with 160mm of PIR insulation, and provides a shadow-free platform for a small solar PV system.

The project was Prewett's first deep energy retrofit — and a learning experience. He says that while thermal bridging could be modelled, predicted and managed, airtightness was more challenging.

The first blower door test score came in around 3.5. "That was the best result the tester had ever got, which made the builder really happy but my life really difficult, because I had to say it wasn't good enough," he says.

The team brought in airtightness expert Paul Jennings to hunt down leaks and ended up with a final result of 1.3 air changes per hour — exceptional for such an old property.

Builder Dave Manby agrees airtightness was the biggest challenge. Blogging about the build, he wrote: "If you go near the airtightness line with a tool - think! Of all the things I have learnt during this build, this is the most important."

Near the end of the build, the team were trying to get the result down from 1.3 to one, and it appeared the airtight windows were leaking a little.

Manby says: "We cleaned the seals and wiped down the joins and when we re-pressured the building the reading was slightly worse! Removing general London grime had reduced their airtightness." He thought plastering would get the house over the line, but it didn't.

He also adds: "Us builders are going to talk more and more about temperature gradients and dew points to clients as insulation levels increase…If the education is not there in several years time we are going to have problems." ▶

To cut down thermal bridging as much as possible, the team studied the house in 3D before work began to identify thermal bridges. This was crucial, as Cohen had decided to install a very minimal heating system — and to rely mainly on the building fabric for warmth.

"We were going to live with the consequences of any failings of the design in terms of low temperatures," he says.

He did install a new modulating Ecotec gas boiler, with output between 4.9 and 12kW, but this only supplies hot water, underfloor heating in the kitchen — supplied by Continental Underfloor Heating — and a bathroom radiator. Not installing a full central heating system was a leap of faith.

"As a building physicist that's what I wanted to test. The theory said it would work, and we never quite know if the theory is going to work out in practice."

So how did it turn out? "We put on an extra jumper if it gets very cold outside, or we retreat to the kitchen where there is underfloor heating. But essentially the house is very comfortable," he says.

Architect Robert Prewett reckons the house could do with one more radiator on the upper ground floor, where there's a large sash window —just for the very coldest days of the year. But by all accounts the house is warm and comfortable.

Heating demand is within 10% of what was predicted. At the outset Cohen envisaged a 40 or 50 year payback, but as energy prices have risen this has dropped to 25 or 30 years.

Due to very low energy use and the feed-in tariff from the small PV system, his household energy costs are "around zero".

The PV system consists of six Sharp 220 watt PV modules, giving a total system size of 1.32kW. According to Jonathan Bates of Photon Energy — who supplied the system — it should produce 1,180kWh and displace 650kg of CO_2 per year.

The renovation cut the house's carbon emissions by four fifths, leading its architect to dub it the 80% House.

But the attention to sustainability here goes beyond direct energy savings: there's the green roof, kitchen furniture made from old floorboards, a counter made from recycled glass, low water toilets, reclaimed pitch pine flooring, and more.

But for the homeowners, perhaps the most important thing is comfort. "The benefits of what we've done are very much in making a nice place to live in. That is paramount," Robert Cohen says. "And we think that that's been achieved."

SELECTED PROJECT DETAILS
Architect & PHPP: Prewett Bizley
Contractor: Dave Manby
Structural engineer: Nabeli Consultancy
Insulation: Knauf/Celotex/Kingspan
MVHR & low water WCs: Green Building Store
Triple glazing: Double Good Windows
Solar PV: Photon Energy
Airtightness consultant: Aldas
Roof membrane: Locker roofing
Airtightness products: Ecological Building Systems
Shading: Mermet
LED lighting: Photon Star
Steel work: Stuart Noel Ltd
Thermal breaks: Foamglas
Wall ties: Ancon
Underfloor heating: Continental
Reclaimed timber flooring: Traditional Timber
Recycled glass counter: Bottle Alley Glass
Condensing boiler: Vaillant

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"If you go near the airtightness line with a tool - think! Of all the things I have learnt during this build, this is the most important."

PROJECT OVERVIEW:

Building type: single dwelling retrofit of early Victorian mid-terrace. 120 sqm finished house including extensions.

Location: Culford Rd De Beauvoir Conservation area, Hackney, London

Completion date: Feb 2010

Passive house certification: not certified, narrowly misses Enerphit criteria

Space heating demand (PHPP): 25 kWh/m^2/yr

Space heating demand (measured): 23 kWh/m^2/yr

Heat load (PHPP): 15 W/m^2

Primary energy demand (PHPP): 134 kWh/m^2 target

Primary energy demand (measured): 77kWh/m^2/yr

Airtightness (at 50 Pascals): 1.3ACH / 1.1 m^3/m^2hr

Energy performance certificate (EPC): A 92

Measured gas consumption 2011 (heating & DHW): 39 kWh/m^2

Measured electricity consumption 2011: 13 kWh/m^2 (of which only 3 kWh/m^2 was imported from the grid)

Thermal bridging
Cavity wall at rear: Low conductivity TeploTie cavity wall ties. Foamglas blocks at base of inner leaf. Also at base of outer leaf where it sits on concrete roof over first floor. Triple-glazed windows suspended in cavity insulation using plywood box.

Front wall: timber joists removed from front wall prior to internal wall insulation. These rehung on new steel spanning party walls.

Lots of other one off details at junctions.

Ground floor: 100mm Knauf floorboard. 30mm stryrene to hold underfloor heating pipes.

Rear wall: stock brick externally, followed inside by 200mm Dritherm 32 cavity fill by Knauf, lightweight concrete block. U-value: 0.15

Front wall: Existing masonry 230mm (ignored for U-value calc as ventilated), 30mm ventilation layer (ignored for U value calc), 12mm plywood, 75mm Knauf Earthwool 32, 12mm OSB, 75mm Knauf Earthwool 32, 12mm OSB, 12mm foil-faced plywood. U value: 0.2

Roof: Prelasti roof membrane, on 12mm plywood PIR 110mm thick, on vapour barrier, on 12mm plywood structural sheathing, on 100mm SW framing/ 50mm PIR. U value: 0.15

Rear windows by Double Good. Triple glazing in timber frame. U value: 0.9

Front windows bespoke joinery with real timber astragals and slim double glazing (6mm cavity filled with argon and with warm edge spacer). U-value not verified but assumed to be approximately 2.0.

Heating system: Eco tec 612 boiler (output 4.9-12 kW) supplying 200L hot water tank, underfloor heating on lower ground, radiator in bathroom on first floor.

Ventilation: Itho HRU Eco4 – not PHI certified – manufacturer quoted efficiency 93%. Summer by-pass included. Lindab rigid galvanised circular ducts.

Electricity: 1.2kWp PV system. The system comprises of 6 x Sharp ND 210W modules, an SMA Sunny Boy 1100 inverter.

Green materials: timber kitchen furniture manufactured from old floor boards. Kitchen counter made from recycled glass. Stone floor in lower ground. Low flush WCs. Reclaimed pitch pine flooring for ground and first floor.

Nottingham upgrade achieves dramatic energy savings

Tina Holt had experience advising homeowners on energy efficiency, so when she wanted a low energy home, buying a run-down 1950s dwelling and aiming to turn it passive was an obvious step. She tells her own story below.

Through my own work helping people to save energy and carbon using behavioural change and energy-efficiency measures — running talks, workshops and seminars, and carrying out home energy surveys — I had become curious about ultra-low energy refurbishment. Fortunately, my partner Richard was just as enthusiastic about taking on a project as I was.

In 2008, with a baby and a second one on the way, we decided that a back garden and a warmer house would be a good idea. Around here, most homes have solid walls, and the few with cavity wall insulation are still not that great for comfort, carbon emissions or energy bills. In the end, we decided to look for a project, in order to undertake a better-than-building-regs energy efficiency upgrade.

Our chance came in October 2009, and within three months we were the proud owners of a solid wall house built in 1952. With the original bathroom, kitchen, single-glazed windows and fireplaces, it was like stepping back in time— and it required a major overhaul both inside and out.

The plan was to wait at least a year before doing anything, but we quickly realised that we were going to be uncomfortable. Apart from the cold, there was a serious issue with condensation and resulting mould. About a month after moving in, the gas boiler went out of action for two utterly miserable weeks. At this point I was weighing up how much insulation we would need, and the experience ultimately led us to aim for the Enerphit standard.

Our friend and eco architect, Gil Schalom, helped pull together our ideas for an extension, loft conversion, open plan kitchen area and a major thermal upgrade. Then he suggested that we get in touch with Alan Budden of Eco Design Consultants for PHPP modelling. Together we wrestled with the permutations that might get us to Enerphit on a site where our detached house is sandwiched tightly between adjacent houses to the north and south.

The passageway on one side and the garage on the other were so narrow that we had to choose between aiming for Enerphit with phenolic foam insulation or abandoning Enerphit altogether and using EPS or something more natural (we ultimately went with phenolic). Deciding to remove the chimneys, maximise airtightness and go for MVHR was something we had to get our heads round early on, but we feel it was the right decision.

We battled the planners, who would have preferred bricks or brick slips on the whole front elevation (they ultimately agreed to have them only on the bay window). The garage was falling down due to drainage issues, the roof was visibly sagging over the cantilevered round bay and all the utilities needed moving for one reason

or another. In the end we decided to rebuild the garage out of structural necessity and deal with anything else that would become an issue in due course. Our motto was 'if in doubt, sort it out' – and there was plenty to sort out.

In October 2011, our ailing gas boiler finally died, we moved to a rented house up the road, and work finally started. The rented house saved my sanity and provided a useful storage facility. We stored all sorts — the floorboards from the original ground floor (they later became the new attic floor), Lindab ducting, and we had a lounge full of EcoPassiv windows and doors.

Our builder had no prior experience of passive house new build or retrofit, but Richard had used the same company for a previous house extension and was confident of a quality job. Unusually perhaps, we did the project on a time and materials basis because neither we nor our builder had attempted anything like this before, and this removed the temptation to cut corners. We bought key items like the windows ourselves, and by being closely involved we were well-placed to spot any issues if they arose.

Together, Richard and I oversaw the project, liaising closely with the builder. My prior building experience extended to painting a wall and putting up a few shelves, so I was glad to leave Richard in charge of the mainstream building work, plumbing and electrics. My remit was to oversee insulation, airtightness and cold-bridge detailing.

Frequent site visits were key to ensuring continuity of insulation. Leaving the children with relatives or friends, I would pop up like a bad penny at any time of day to seek out gaps. Everything from down-stands, up-stands and insulation beneath ground level to the external wall insulation (EWI) and roof insulation was checked thoroughly before it disappeared under the next layer of the construction. Thankfully the builders really seemed to get it.

Having our architect just five minutes down the road was extremely useful, both for briefing the team at the start of each step, and for dropping round if I spotted an issue. At every stage, a few minutes discussion with the relevant people helped to ensure that everything was buildable and that each person knew how their bit fitted in with the rest.

We knew that airtightness would be our biggest challenge because of the complex roof structure. The air barrier is internal: plaster on the masonry walls and Intello membrane for timber structures such as the roof and the new front bay. However, we doubled up by taping the roofing membrane (Solitex Plus) on the outside of the insulation as a wind barrier. With hindsight, it would have been worth parging the external walls before adding EWI as this would almost certainly be more effective than just using a near-continuous covering of adhesive on the insulation boards.

To minimise costs, Richard and I did most of the airtightness taping ourselves. We were very impressed with the Pro Clima products and quite enjoyed the work — although the novelty had rather worn off by the time we'd finished the joists going into the eaves.

There were a few worrying moments — like having a house with no roof. As if that were not enough, we ran open home tours at each stage of the refurbishment to share knowledge with interested householders and professionals. To my great relief, in spring 2012 the new roof was on and the external wall insulation below the damp proof course could begin.

During the summer the external insulation was completed, the ventilation ducts went in, the garage was re-built and internal airtightness work began. To make the most of the thermal mass provided by the brickwork, we used a dense render on the internal walls and a thin skim of gypsum plaster. (It was like walking into a rainforest just after the plastering was done – but we cleaned the house up, switched on the MVHR and humidity dropped to normal levels.) In October 2012, exactly a year after moving out, we moved back in to our lovely warm shell. While the airtightness test result of 1.08 air changes per hour fell just short of Enerphit, we were not too concerned – the back door hinges needed adjustment and air was leaking spectacularly along the full height of the door. It took almost a year before we got around to having it adjusted correctly, by which time Richard had made a load more holes which we have yet to rectify. So currently airtightness sits between 1 and 2 ACH. This raises the issue of DIY in passive houses and whether the decision to rely on an internal air barrier was the right one. But that's a topic for another day.

Construction aside, how does the house perform and was it all worth it? We are extremely pleased with the level of thermal comfort and are total converts to the improved air quality provided by mechanical ventilation with heat recovery. One of my favourite features is the drying cupboard in the bathroom. Being able to dry clothes quickly indoors is life-changing, as is the absence of condensation and mould on the windows and walls.

Before the refurbishment, humidity levels were commonly at 60 to 70% and occasionally as high as 90%. Now they generally stay between 45% and 55%, even in the bathroom-cum-drying room.

The temperature records (from dataloggers) back up what we can already feel: that we are benefitting from improved comfort — not just with higher average temperatures, but much more stable temperatures. The internal temperature used to yo-yo as the heating system tried to keep pace with heat loss. Now it's really easy to keep the house as we like it (around 20-21C in the day and 19-20C in the bedrooms at night).

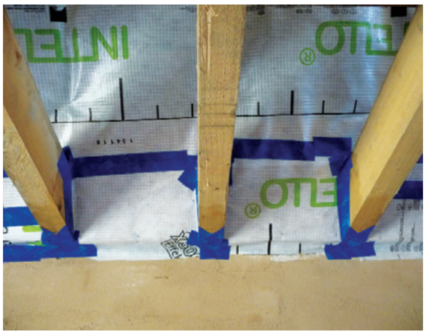
Energy use for 2013 shows an actual space heating demand of 27 kWh/m²/yr, compared with 24 kWh/m²/yr as modelled — both values based on the PHPP floor area of 125sqm. Of course, in the first quarter of 2013, our three little radiators were still heating up the brickwork and drying out the plaster in what was a colder than average winter.

I've heard various anecdotes about health improvements resulting from passive house air quality so it came as no surprise that we are all benefitting from better respiratory health. But there has been one completely unexpected benefit for me: after an accident 25 years ago, several months of joint pain is the norm every winter. And since moving back into our refurbished house, I've had none at all.

Now that we live in a low energy home, can we abandon the energy saving behaviours that we previously used to keep our bills from spiralling out of control? We think not. Although we have certainly taken significant benefit in comfort, we have retained many of our original energy saving habits and learned some new ones, particularly around heating and ventilation control. I suspect that to achieve its full energy-saving potential, every low energy home still needs energy-savvy occupants.

SELECTED PROJECT DETAILS
Clients: Tina Holt and Richard Middup
Architect: GSD Architecture
Passive house consultant: Eco Design Consultants
EPC Assessor: Andy Beckford
Main contractors: McCane Construction
External insulation: Permarock
Mineral wool: Knauf
Windows & doors, MVHR & sanitaryware: Green Building Store
Roof windows: Fakro
Airtightness membranes, tapes and grommets: Green Building Store
Airtightness testing: Midland Energy Services
Ventilation ductwork: Lindab
Solar PV: Solar World panels installed by Carbon Legacy
Thermal breaks: Marmox
Roof insulation: Ecotherm

(from left) The original house was built in 1952 and required a major overhaul both inside and out; the ground floor features 300mm platinum EPS insulation under a 100mm concrete slab.



(above) the Pro Clima system takes care of airtightness in the roof build-up, which was a challenge because of the complex roof structure; (below) the house's external walls are insulated with a Permarock system including 180mm of phenolic foam insulation. Windows sit proud of the blockwork to ensure a continuous insulation layer; a wall to pitched roof insulation detail.

PROJECT OVERVIEW:

Building type: 1950s solid wall brick house, east-west orientation, detached (91sqm extended to 125sqm)

Location: Nottingham

Budget: Approx £200k including extensions, full refurbishment, full and internal fit-out, garage rebuild, landscaping

Space heating demand
Before: 458 kWh/m^2/yr according to EPC at time of purchase **After:** 24kWh/m^2/yr (PHPP)

Heat load
Before: not known **After:** 10 W/m^2

Primary energy demand (PHPP)
Before: not known **After:** 81 kWh/m^2/yr

Primary energy demand (measured)
Before: 330 kWh/m^2/yr **After:** 81 kWh/m^2/yr

Energy performance certificate (EPC)
Before: E 39 **After:** B90 (predicting space and water heating total of over 13,000 kWh/yr compared with actual value of 5,345 kWh in 2013)

Measured total energy consumption
Before: 275 kWh/m^2/yr (Apr 2010-Mar 2011) **After:** 56 kWh/m^2/yr (Jan-Dec 2013), not including PV use or generation. Electricity figure used is as purchased from the grid.

Measured space heating
Before: 219 kWh/m^2/yr (Apr 2010-Mar 2011) **After:** 27 kWh/m^2/yr (Jan-Dec 2013)

Energy bills
Before: roughly £2,000 at today's prices **After:** Gas & electricity combined use = less than £450 plus standing charges on top (Jan-Dec 2013) (Note: annual PV income exceeds the total gas and electricity bill)

Airtightness (at 50 Pascals)
Before: not known **After:** 1.08 air changes per hour

Walls
Before: solid brick walls, no cavity. U-value: 2.1 **After:** Permarock external insulation system comprising mineral render finish externally (brick slips on bay), 180mm phenolic foam insulation in 2 cross-bonded layers on solid brick walls. U-value: 0.13. Below DPC down to footings (800-1000mm below ground) — 160mm of insulation suitable for below ground use

Extension walls
Permarock external insulation system comprising mineral render finish externally, 180mm phenolic foam insulation in 2 cross-bonded layers and 140mm dense block walls. (Turbo blocks and Marmox structural insulation below DPC) Sand-cement render internally throughout extension and house with gypsum skim (to maximise access to thermal mass). U-value: 0.13

New square bay walls
Permarock system as above but to timber frame. 12mm OSB outside 100mm frame with 100mm glass mineral wool (Crown Rafter Roll 32) between. Intello membrane and Tescon tapes with Contega joining to adjacent plaster. Studs and 12.5mm standard plasterboard and skim internally. U-value: 0.098 W/m^2K.

Existing pitched roof
Before: concrete roof tiles (in poor condition) with little remaining felt (hanging in shreds). **After:** new concrete tiles over Solitex Plus roofing membrane, then 100mm foil faced PIR. Below that, between the new 150mm joists – Crown Rafter Roll 32 glass mineral wool, Intello membrane taped with Tescon No 1 and Uni Tape, 25mm battened service void (unfilled) and plasterboard. U-value: 0.13

Flat roof: flat roof membrane above 100mm PIR over 18mm OSB3 deck, then Crown Rafter Roll 32 and rest of build up as per pitched roof. U-value: 0.13

Extension roof: As for main roof: concrete tiles with battens and counterbattens over Solitex Plus roofing membrane, then 100mm foil faced PIR. Below that, between the joists – 150mm Crown Rafter Roll 32 glass mineral wool, Intello membrane taped with Tescon No 1 and Uni Tape, 25mm battened void (unfilled) and plasterboard. U-value: 0.13

Windows & doors
Before: single-glazed with leaded lights and rotten timber frames.
New triple-glazed windows: Green Building Store triple-glazed EcoPassiv doors and windows. Overall U-value: 0.75
Roof windows: Fakro FFT U8 Thermo Passive House certified roof window, quadruple glazed. Overall U-value: 0.58

Floor
Before: Original suspended floor (and solid floor in kitchen) with carpets **After:** Compacted and blinded hardcore sub-base, Primary DPM, 300mm Platinum EPS at 0.030 conductivity, second DPM / separating layer, 100mm concrete slab on blinded sub-base, 40mm floating screed laid directly onto slab, Membranes and slab taped and sealed to wall plaster using Pro Clima products including DA-S.

Floor edge insulation: Against all existing retained walls (internal and external) 150mm Platinum EPS taken from underside of slab level all the way down to the footings (approx. 700-800mm vertically), applied internally to external walls and both sides of internal walls. Slab edge insulation 100mm Platinum EPS, screed edges 35mm foil faced PIR edge insulation.

Heating system
Before: 10+ year old oil boiler & radiators. **After:** ATAG A203C gas combi boiler (89.3% efficient, SAP2009 – Sedbuk database) with 3 small radiators, later increased to 5 for flexibility.

Ventilation
Before: No ventilation system, reliant on infiltration and chimney for air changes. Window frames were too swollen to open. **After:** Paul Focus 200 heat recovery ventilation system. Passive House Institute certified to have heat recovery rate of 91%.

Green materials: Earthborn clay paints, re-used floor boards from ground floor to create new attic floor, roof timbers, joists and some bricks re-used in house or garden, some second hand furniture and fittings, attempted to minimise building waste.

Electricity: 13 x 250W Solar World panels (3.25kW PV system) and Power One inverter.

A2 rated extension & upgrade, Co Cork

This upgrade and extension to a rural home in County Cork cut its energy use by almost 90%, bringing it to the cusp of an A1 Building Energy Rating.

Two engineers brought their technical minds to this retrofit and extension in Carrigtwohill, Co Cork — and created a warm, energy efficient home in the process.

Emma and Rob had each owned separate homes, but after getting married decided to put one up for sale.

"His house was on a site in the country where both of us preferred to live," Emma says — so they decided to sell her house.

Parts of Rob's 1980s cavity wall house were cold and damp, other parts were fine. But the layout wasn't ideal, and the couple wanted to make the space more efficient and usable. Being engineers, they were keen to get their teeth stuck into the technical details. "We weren't going to compromise on the energy side of it," says Emma.

The couple interviewed various architects and selected Cork-based Andrew Lane. Their main design goals were to maximise natural light and views over the east Cork countryside, and to create a modern, open plan living space in the extension — thus allowing them to re-task rooms in the old house.

But the project stalled when it took Emma a year to sell her old house. This turned out to be a blessing in disguise, as it gave the couple more time to research low energy building.

Carrigaline-based Vinro Ltd was appointed builder, while John Roche – then of Permagreen – was insulation and airtightness contractor for the retrofit of the old house.

Not wanting to lose any floor space, Emma and Rob chose to insulate the original house externally with 150mm of graphite EPS, finished with mineral render and installed by John Roche, who also pump-filled the existing 50mm cavity with Isothane Technitherm polyurethane foam.

The attic had previously been insulated with 300mm of mineral wool between the joists. But as part of the upgrade John Roche sprayed the sloping rafters with an extra 150mm of Isothane Duratherm, a rigid polyurethane spray-foam.

Getting the insulation and airtightness right in the old part of the house was the biggest challenge, says architect Andrew Lane.

"We in effect wrapped the building to create a warm structure, but the existing floor structure was a challenge as we did not want to take up the existing floor slab," he says. The solution here was to lay 50mm of Kingspan PIR insulation on top of the existing slab.

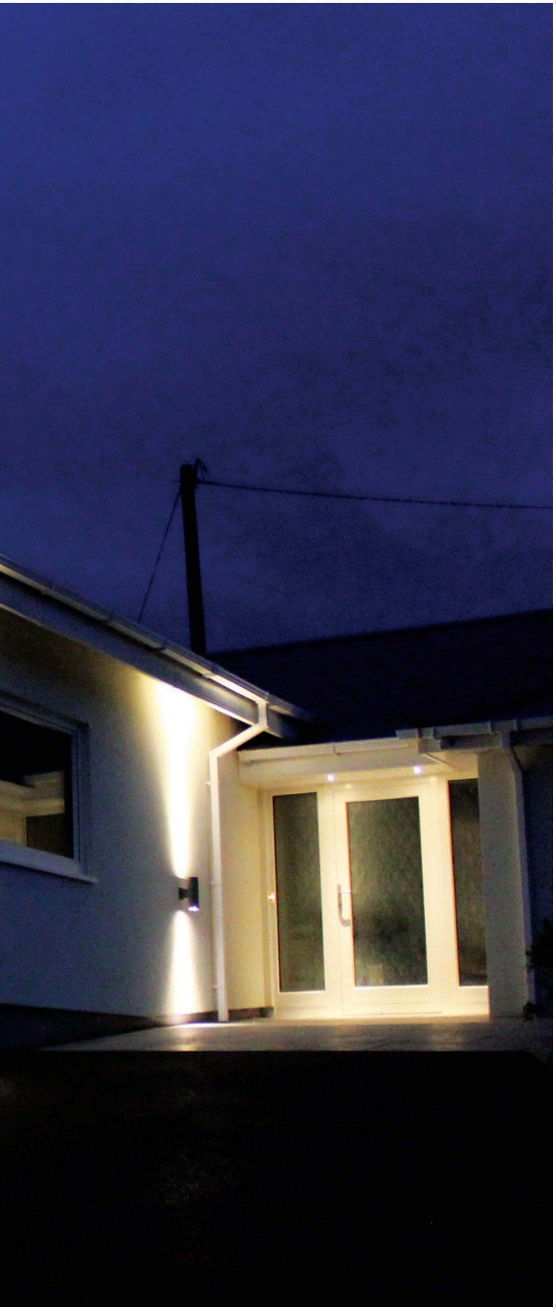
The extension was constructed with a factory-built timber frame from Cygnum. Emma and Rob opted for the company's Precision 300 wall system, which delivers a wall spec pitched at the passive house market, including a U-value of 0.13.

The couple always preferred timber frame over block. "It's warmer, it goes up a lot quicker than block. We didn't want a long construction schedule," Emma says.

Cygnum's Heber McMahon calls Precision 300 the "Rolls Royce" of their timber frame systems. This was one of the first projects in which it was used, but he says demand has grown rapidly since.

The walls are insulated with 300mm of factory-fitted cellulose, with an insulated thermal break in the studwork to prevent cold bridging. The service cavity is packed with high density Metac mineral wool. Emma was attracted to the efficiency of a closed panel system — one that arrives pre-insulated, rather than being pump-filled on site.

The sloping extension roof features 300mm of high-density Metac mineral wool between the rafters, while a flat-roofed section has 400mm of the same. Airtightness is provided by German-manufactured Gerband tapes and membranes, supplied by Clean Energy Ireland.



The couple insisted on detailed attention to airtightness during the build, and the whole house — old and new parts combined — scored 1.6 m³/mhr/m² air permeability on its final blower door test.

"That's nothing to be sneezed at for a bungalow of that vintage," says Rodney Cronin of contractor Vinro. Rodney says the house is Vinro's most energy efficient project to date — though he's used to building well in excess of the building regulations.

"It was very straightforward because Emma had all her homework done," he says of the job. "They were the perfect client, they knew exactly what they wanted."

Building a low energy extension set a high standard that the team aimed to match for the retrofit, according to Andrew Lane. "I also learned how vital it is to have good coordination between the trades if you are seeking an airtight building. In this case we were fortunate to have a first class contractor who made this process as smooth as possible," he says.

Carey Glass Joinery installed windows and doors throughout the house. The windows are alu-clad with hardwood Iroko inside. Both the doors and windows are triple-glazed and feature the company's Vista Therm Elite SE glass with black, warm edge spacer bars.

There's also six Fakro FFT thermally broken triple-glazed roof window, helping to create a bright, airy kitchen space, and large windows in the sitting room maximise daylight.

The heating set up features four thermodynamic panels — a hybrid of solar and heat pump technology.

The panels feature a liquid refrigerant that has a boiling temperature of -25C. Sited on the roof, they absorb heat from the surrounding environment. This raises the temperature of the refrigerant and converts it from liquid to gas. The refrigerant is then recompressed into a "super saturated" liquid by an electrically-powered compressor. It is then passed through a heat exchanger, warming up water in the cylinder.

There's also a fifth thermodynamic panel for hot water production. But the 50 solar evacuated Sun Pro tubes get priority here.

"Hot water is provided by the evacuated tubes when solar gain is present and then by the thermodynamic panel when there is no solar gain," says Eamonn Ryan of Complete Alternative Energy, who designed and supplied the system. "This heats a 300 litre domestic hot water stainless steel cylinder."

"The space heating system is controlled by the four panel thermodynamic system and any surplus energy from the solar tubes after heating the domestic hot water first is then dumped into the 500 litre buffer tank for space heating."

Passive House Plus had heard reports of some thermodynamic systems frosting over, and Eamonn says when they are are undersized and overworked, they can freeze up.

But he argues that properly designed systems won't encounter these problems — in this case having four panels for space heating and a separate panel for hot water means no panel is put under excess pressure. He says the system installed at Emma and Rob's house is a replica of the one in his own home.

For heat distribution, underfloor heating was installed in the extension. Radiators were stripped out of the old house and replaced with low temperature aluminium units.

The ground floor features Cemex's high thermal conductivity Supaflo screed.

"It's using the latest screed specially designed for underfloor heating," says David Kelly of Cemex. "It can be laid far thinner than traditional screed, and it has a higher thermal conductivity than traditional cementitious screeds."

Complete Alternative Energy also supplied and installed a solar photovoltaic system to the house, a 3kW IBV solar system that produces about 3,000 kWh per year, according to Eamonn Ryan — roughly €600 worth of electricity. Because their main heating system is based on electricity, putting in PV made sense, and Emma and Rob are thinking about putting up a wind turbine too.

Emma says the thermodynamic panel system kept the house at 19C through the winter. The ▶

The couple preferred timber frame over block. "It's warmer, it goes up a lot quicker than block. We didn't want a long construction schedule."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house is also equipped with a standalone Fondis V90L wood burning stove, but the couple say it isn't essential for keeping the house warm and is only used for extra comfort on cold days.

There's also a heat recovery ventilation system—a ProAir 600 unit manufactured in the Éasca approved company's Galway factory.

Emma and Rob are happy with the upgrade: "It's performing very well at the minute, we wouldn't have any complaints whatsoever."

They add: "It took us I'd say six months to get used to how the controls worked and how everything worked properly, but this year now it's worked a dream."

SELECTED PROJECT DETAILS
Architect: Andrew Lane Architects
Contractor: Vinro
BER: GeoData Surveying Ltd
Timber frame system: Cygnum
Insulation & airtightness contractor: John Roche
Slab insulations: Kingspan/Xtratherm
External insulation system: Alsecco
Windows & doors: CareyGlass
Roof windows: Tradecraft
Airtightness products: Siga/Clean Energy Ireland
Flooring: Quick-Step
OSB: Smartply
Floor screed: Supaflo
Floor screed contractor: Apollo Screed
Cement fibreboard: Greenspan
Renewable energy systems: Complete Alternative Energy
Heat recovery ventilation: ProAir Munster Ltd

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Click here to view additional information on these projects, including an online gallery featuring illustrations, photographs, and project overview panels.

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(clockwise from above) The new extension comes together, with airtight layer; insulation added to the service cavity before plasterboarding; (p61) (middle left) the external walls of the extension feature 12mm Aquapanel cement fibreboard; (bottom left) not wanting to lose any floor space, the clients chose to insulate the external walls of the original house with 150mm of graphite EPS; (bottom right) all windows and doors throughout the house are triple-glazed.

PROJECT OVERVIEW:

Building type: Existing 133 square metre 1981 bungalow of block construction, plus 70.5 square metre timber-framed extension

Location: Carrigtwohill, Co Cork

Completion date: August 2012

Enerphit certification: not applicable

BER
Before: D2 (267.58 kWh/m²/yr) **After:** A2 BER (31.86 kWh/m²/yr)

Space heating demand, heat load and primary energy demand (PHPP): not calculated

Energy bills
Before: €1,600 on home heating oil & €460 on electricity **After:** Estimate €1,050 per annum total (inclusive of rebate for electricity exported to the grid)

Airtightness (at 50 Pascals): 1.61 m³/hr/m² / 2.433 ACH

Existing walls
Before: external render, 100mm brick outer leaf, 50mm cavity (cavity partially filled with unknown white substance), 100mm block inner leaf, Internal skim finish on sand-cement scratch coat. U-value: 0.5
After: 150mm graphite EPS external insulation and acrylic render finish externally, cavity filled with Technitherm foam insulation. U-value: 0.16

Extension walls: 12mm Aquapanel cement fibreboard externally, followed inside by 50mm ventilated cavity, breather membrane, 9mm OSB, 150mm structural stud (with cellulose insulation), 53mm cellulose-insulated cavity/thermal-break, 89mm structural stud (with cellulose insulation), 9mm OSB, airtight membrane, 50mm service cavity insulated with Metac mineral wool, 12.5mm plasterboard. U-value: 0.13

Existing roof
Before: Roof slates to sloped areas externally. 300mm mineral wool insulation on the flat between roof joists and plasterboard ceiling internally. U-value: 2.3 **After:** Roof slates to sloped areas 300mm mineral wool insulation on the flat between roof joists and 150mm of Duratherm spray foam insulation between the rafters. U-value: 0.16

Existing floor
Before: 25mm Aerobord insulation under existing concrete floor. **After:** Upgraded with 50mm Kingspan PIR insulation over the slab, plus two layers of 11mm OSB above this. U-value: 0.24 Plus, 100mm Kingspan PIR under the bathroom, en suite and plantroom in the old house.

Extension floor: Insulated with 230mm PIR insulation. Underfloor heating and Cemex Supaflo screed. U-value: 0.10

Extension roof: Raised tie roof trusses and infill rafters. Tegral fibre cement slates externally on 50x35 battens/counter battens, followed underneath by breathable roofing underlay. Slope ceiling: 300mm timber rafter filled with 250 high density quilt insulation, airtight membrane taped & sealed, 50 mm uninsulated service cavity, 12.5mm plasterboard ceiling. U-value: 0.14 Flat ceiling: 400mm thermal insulation, airtight membrane taped & sealed, 50 mm uninsulated service cavity, 12.5mm plasterboard ceiling. U-value: 0.11

Windows & doors
Before: Double-glazed PVC windows and doors. Overall approximate U-value: 1.9. **After:** New triple-glazed windows: CareyGlass triple-glazed Aluclad Iroko windows and doors. Aluclad french doors & single doors U-value: 1.3.
Aluclad sliding doors: U-value: 1.1. aluclad triple-glazed windows U-value: 0.9.

Roof windows: Fakro FFT 12 U5 thermally broken triple-glaze roof window with thermally broken timber frames complete with XDP external overfelt kit. Overall U-value: 0.94 W/m²K

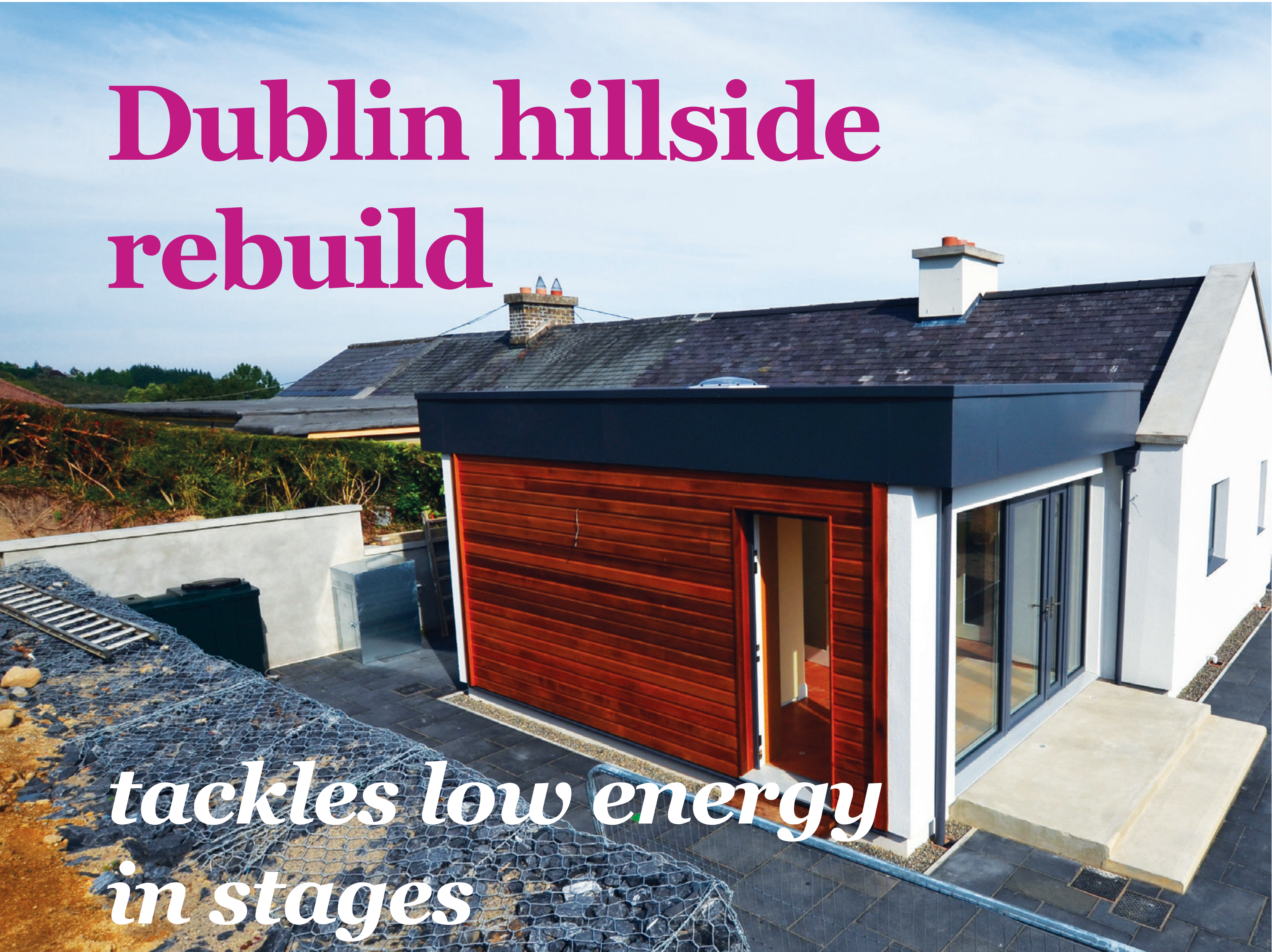
Heating system
Before: 16 year old oil boiler (Firebird Popular 82, efficiency 85.5%) & radiators throughout entire building
After: 4 thermodynamic panels (COP 4.0) to heat 500litre tank which supply underfloor heating in the extension, main bathroom and ensuite and aluminium radiators in the existing part of the house. Fondis V80L inset stove, up to 11 kW.
1 thermodynamic panel for the hot water along with 50 solartubes.

Ventilation
Before: No ventilation system. Reliant on infiltration, chimney and opening of windows for air changes
After: ProAir 600 heat recovery ventilation system

Electricity: 12m² solar photovoltaic array with average annual output of 3kW

Dublin hillside rebuild

tackles low energy in stages



Some buildings are beyond saving, such as a south Dublin cottage which had to be knocked to deliver the first phase of a sleek new low energy home.

Words: Lenny Antonelli

For one family, building a low energy home in the hills of south Dublin proved to be a bit more of a rollercoaster than they anticipated. In 2010 Nick Burrett and Orla O'Shea bought a Victorian cottage in Stepaside, Co Dubin with the intention of renovating it a year or so down the line.

"When we bought it, it was in a terrible condition anyway, we knew we had to do work on it," Nick says. Both the roof and back wall were in danger of collapse.

They planned to renovate the cottage and build a large extension in one go. Architect Hugh Geoghegan's practice Archi-i was appointed to design the project, with Dublin-based Bourke Builders as contractor.

"The build quality was terrible – it allowed for massive heat losses and rodent infestation," Hugh says. And the team weren't long on site when they got a big shock. "We were three weeks into work on site when it became clear that the fabric of the existing dwelling could not be salvaged."

The existing structure was infected with dry rot and mould, and there was substantial water damage. Pipes had frozen and cracked while Nick and Orla were away, soaking the roof timbers. The level of damage caused by water ingress only become obvious once the builders started pulling apart the old cottage.

They decided to knock the original structure and build a new cottage instead. "There was a lot of on-the-hoof design, it was quite challenging," says Hugh. On the positive side, it gave Orla and Nick a chance to build a new, energy efficient home.

What's more, the clients had more difficulty getting a mortgage than they expected. They put plans for the extension on hold and opted to finance the rebuilding of the cottage out of their own cash reserves.

The site is also on a granite hill, and the team worried they would end up having to excavate a big chunk of granite — potentially another big cost. But they wouldn't know until the diggers were on site. Pushing the extension back and focusing on the cottage first would help to keep those groundwork costs under control should they arise.

The old cottage was knocked, and work began on its replacement. The walls of the new cottage were built with concrete block, externally insulated with EPS and finished with mineral render. The new sloping roof is insulated with 400mm of Knauf Earthwool mineral wool between and over the rafters, plus 40mm of Gutex Thermoroom woodfibre insulation fixed to OSB under this, while the flat roof is insulated with 200mm of mineral wool and 100mm of Gutex Thermoflat wood fibre.

Munster Joinery triple-glazed Future Proof Passiv timber-alculad windows were installed through the property, and there are triple-glazed Velux roof windows too.

The airtight layer is provided by plaster on the block walls, and by Pro Clima membranes and tapes — supplied by Ecological Building Systems — in the roof. The final airtightness test, performed by Gavin O Sé of Greenbuild, produced a result of 1.95 air changes per hour. Greenbuild also assessed the house under the Code for Sustainable Homes, and it came in at level four.

There's no whole-house ventilation system, only standalone extract vents in individual rooms, but the house has been built to take HRV ducting which will be installed when work on the extension begins — though Nick now says he wishes they'd installed it up front.

Of course Nick and Orla's goals went beyond energy: they wanted the house to fit into the local landscape, and to avail of the site's views over Dublin Bay. The original cottage was on a low point of their site, and the view was blocked by a hedge.

The new design opens up the view, and makes more use of the surrounding site.

"The project threw everything at the client and they dealt with adversity with character and good humour," says Hugh. He adds: "I take my hat off to Neil Skelly, our quantity surveyor. A cool head was needed at times and he provided that."

Ironically, the team ended up finding no solid granite. But Nick thinks that ultimately, not being able to do the whole extension at the same time was a blessing in disguise. "I think if we'd have done it all in one go like we were going to, we'd have had a big problem financing it in the end."

Nick and Orla moved in last October, and have been impressed with how the house has performed over the winter.

"There's very little temperature drop throughout the night so it's quite comfortable to just sit around in the early hours of morning, which we have been doing because we have a young baby. Heat retention has been very good."

"I realised that it's better to invest the money in insulation and doing it to a high specification, because it saves a fortune in the long run really."

They've only used up about a quarter of their 600 litre oil tank since October, whereas previously they'd have gone through a 1,000 litre tank every six to eight weeks.

Nick expects detailed design of the extension to begin in the autumn — considering it will be almost four times the size of the cottage, the energy efficiency goals will be higher there.

"We've rebuilt a cottage and have an understanding of the materials used in the construction and their performance," Nick says. "We have an energy efficient home and a much clearer idea of how to improve things for the construction of the larger extension."

SELECTED PROJECT DETAILS

Clients: Nick Burrett & Orla O'Shea
Architect: Archi-i
Civil & structural engineering: Thorne Consulting Engineers
Main contractor: Bourke Builders
Quantity surveyor: John D Skelly & Associates
Airtightness testing: Greenbuild
External insulation system: Saint-Gobain Weber
Roof insulation: Knauf
Floor insulation: Kingspan
Airtightness products & additional roof insulation: Ecological Building Systems
Windows and doors: Munster Joinery
Oil boiler: Grant
Lighting: National Lighting
Radiators: Quinn

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(below left) The unsalvageable fabric of the existing dwelling was knocked; (below) the site is on a granite hill; (bottom) the external walls of the new cottage are concrete block insulated (right) with 200mm of EPS with the exception of a timber clad façade that will eventually link to a two-storey extension.

PROJECT OVERVIEW:

Building type: 52 sqm externally-insulated blockwork cottage

Location: Stepaside, Co Dublin

Completion date: August 2013

BER: pending

Space heating demand/heat load (PHPP): not yet calculated

Code for Sustainable Homes: Level 4

Airtightness: 1.95 air changes per hour at first fix, further test pending

Walls: 200mm EPS insulation and Weber mineral render finish externally, on 220mm concrete blockwork U-value: 0.13

Sloping roof: Pro Clima Solitex wind tight membrane externally. 400mm Earthwool insulation between and over rafters, on 22mm OSB mechanically fixed to rafters, 40mm Gutex Thermoroom mechanically fixed onto OSB, on Pro Clima Intello membrane, on 12.5mm plasterboard to underside of ceiling, skimmed finish. U-value: 0.11

Flat roof: EPDM single ply roofing membrane, on 100mm Gutex Thermoflat insulation, on 9m T&G red deel, on firring pieces, on timber joists, on Intello Plus membrane, on 200mm mineral wool insulation between timbers, on 12.5mm plasterboard with 3mm skim finish. U-value: 0.12

Ground floor: Kingspan Thermafloor TF70 150mm under concrete screed with min. 25mm vertical strip of TF70 to the perimeter of slab to prevent cold bridging. U-Value: 0.12

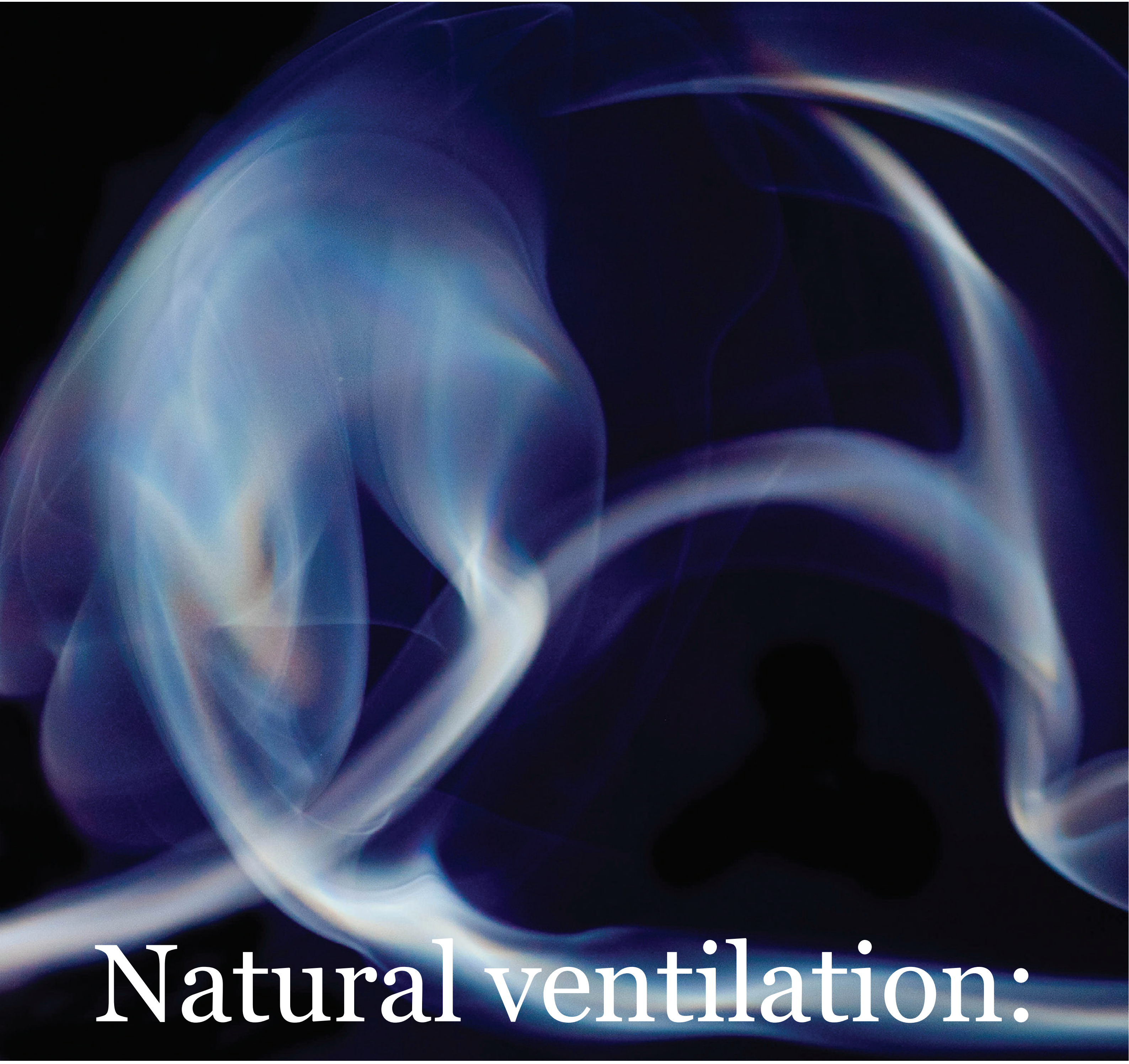
Windows & doors: Munster Joinery triple-glazed Future Proof PassiV timber aluclad windows and doors. Overall U-value: 0.8

Roof windows: Velux triple-glazed flat roof windows

Heating: Grant Euroflame Oil Boilerhouse model, 70-90,000Btu/hr (21-26kW)

Ventilation: no whole-house ventilation system. Reliant on extract fans to individual rooms, plus infiltration, chimney and opening of windows. MVHR to be retrofitted as part of phase two.

Green materials: recycled blue Bangor slate, recycled pine flooring, infill to gabions from excavated rock on-site



Natural ventilation: *does it work?*

Such is the importance of ventilation, it's only right and proper that the efficacy of innovative mechanical solutions such as heat recovery ventilation and demand controlled mechanical extract ventilation is established based on robust, comprehensive evidence. But how does natural ventilation fare when subjected to the same degree of scrutiny, and can it work in low energy buildings?

Words: Kate de Selincourt

At the Alliance for Sustainable Building Products' recent London event "Healthy Buildings, Healthy People"[1] the speakers all addressed the concern that "low carbon" – for which read, airtight – homes may be endangering the health of their occupants, via reductions in air exchange and indoor air quality. This perception is widespread, despite the fact that in theory, the building regulations are supposedly 'keeping up' with increases in airtightness, and adapting ventilation requirements accordingly.

At the same time, there's a lot of concern about the use of mechanical alternatives to traditional "natural" ventilation, particularly in dwellings, with mechanical ventilation perceived as complicated and potentially dangerous to health. By contrast, natural ventilation often seems to be seen as – well – "natural", and relatively unproblematic.

Among the benefits commonly ascribed to natural ventilation are that it puts the occupant in control, it's silent and energy efficient. People also suggest that it allows the occupants to be in contact with the outdoor environment, it's "self regulating", and it allows the building to "breathe".

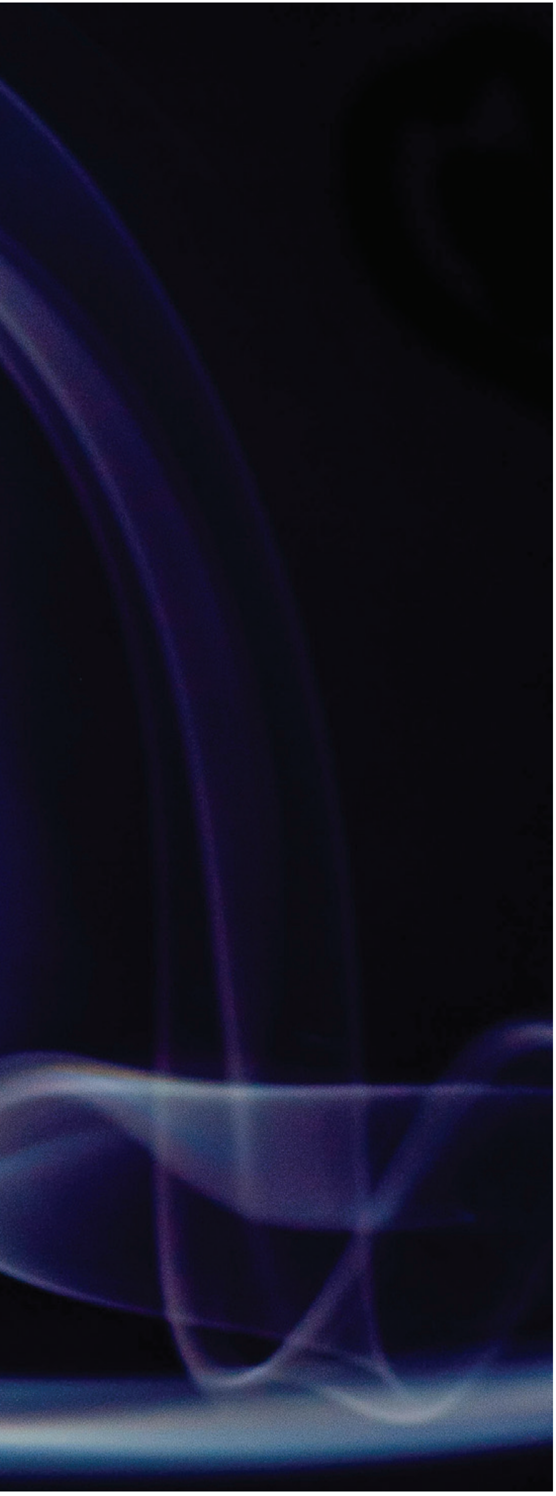


Photo: David Garcia Perez

But does natural ventilation actually do that basic thing, give occupants enough fresh air, and remove indoor air pollution, effectively?

One person worried about this is Neil Jefferson, director of the NHBC and chief executive of the Zero Carbon Hub.

Writing in Building Magazine[2] Jefferson welcomed the recent publication by the NHBC Foundation of a commendably honest account highlighting a string of concerns in the design, specification, installation, commissioning and operation of MVHR systems in 10 'zero carbon' homes.[3] But he went on: "There is no reason to assume that other modes of ventilation are really performing any better. MEV and PSV might well share some of the issues."

He went on: "What about background ventilators and intermittent extract fans (aka trickle vents and cooker hood and bathroom fan)?

"Although these systems are simple to understand and use, there is anecdotal evidence suggesting that even this most simple of systems is not used properly. The trickle vents left open or closed, dependent on the weather on moving-in day; cooker hoods not used because you can't hear the telly; and, let's be honest, who ever cleans the filter?"

You can't get away from the fact that if you're relying on the natural forces of wind and weather to get fresh air into your building, you are at the mercy of the wind and weather.

How does natural ventilation perform in theory?
Natural ventilation works by exploiting pressure differences driven by wind, or by temperature differences (the buoyancy effect), to move air in and out of different parts of a building. You can't get away from the fact that if you're relying on the natural forces of wind and weather to get fresh air into your building, you are at the mercy of the wind and weather. On windier days and/or days where there is a greater temperature differential between indoors and out, air will move readily and ventilation rates will tend to rise; in stiller or milder weather, ventilation rates will drop.

Bob Lowe (when he was at Leeds Metropolitan University) did some theoretical calculations based on realistic weather conditions, which he says illustrate "some of the fundamental problems" associated with natural ventilation. He carried out careful modelling taking into account both wind speed and direction, and buoyancy effect.[4]

He then calculated the "under-ventilation index", meaning the proportion of the heating season for which a naturally ventilated dwelling will be underventilated without additional window opening. "At leakage rates below about 8 ACH-1 at 50 Pa, under-ventilation [for a proportion of the time] is almost assured," he concluded.

Despite not enjoying consistently good ventilation, Dr Lowe's calculations showed that such dwellings would lose heat unnecessarily in very cold or windy weather, and be overventilated overall: "Even at this level of leakage, the ventilation rate averaged over the heating season is significantly greater than the design ventilation rate."

What happens in practice?
There's very little field evidence reporting the performance of natural ventilation. A small study of 22 homes of different types was carried out in 2009 for the UK government to investigate whether Part F 2006 was providing adequate ventilation and IAQ in homes, and whether it should be updated at the next review in 2010.

The researchers were particularly keen to find relatively airtight homes, as these were the focus of concern about IAQ, and this batch ranged in permeability (measured with vents closed) from well below four (these were generally flats) to over ten (ie leakier than the supposed maximum of the day), averaging at around six air changes per hour at 50 pascals.[5]

The pollutants measured were moisture, TVOCs, formaldehyde and nitrogen dioxide. As the authors put it, "to assess whether ADF 2006 recommendations were adequate, it was necessary for the ventilation system to be used to its full capacity", so occupants were asked to keep trickle vents fully open and use extract fans at their highest setting during cooking and bathing; they were asked to keep windows shut.

Air change was estimated using a gas diffusion technique, and this showed that all five flats, and 40% of the houses, failed to achieve their recommended background ventilation rate (as calculated on the basis of dwelling size and occupancy, as set out in the then Part F England & Wales).

Nitrogen dioxide levels in the kitchen exceeded performance guidelines in four homes, and over half of the homes where measurements could be taken had total volatile organic compound (TVOC) levels exceeding the guideline.

The underventilation could not however be laid directly at the door of the regulations of the time, as few if any of the dwellings had the recommended ventilation installed. The area of trickle ventilators was less than that recommended in three quarters of the homes; half did not have the required gap under doors, and less than half of the extract fans achieved recommended air flows. Flats had a particular issue in that they did not meet the Part F additional guidance for dwellings where most ventilation is on a single aspect.

There's certainly a more widespread problem with installation and enforcement than in just this one study. The University of Strathclyde's Stirling Howieson has reported on the basis of his recent research that "technical standards prescribed by the Building Regulations are not being enforced"[6]; this observation was also confirmed by delegates at a 2013 Good Homes Alliance seminar on ventilation, in which representatives from industry reported seeing many installations which in "no way had the ▶

vent areas to meet Part F, but they were being signed off by building control".

The undersized installations in the 2009 DCLG study gave natural ventilation an uphill struggle: in the most airtight dwellings, even with all vents open, permeability was 6 ACH @50pa or below. According to Lowe's calculations this would leave them underventilated at least half the time across a heating season. Although it was therefore hard to appraise Part F directly, the authors of the study carried out some calculations to project likely air change rates and IAQ had the correct vents been fitted – this did suggest a number of homes would still have had problems with IAQ, in particular, TVOC levels.

The team also modelled the likely impact had all the homes been built to the levels of the most airtight: unsurprisingly, IAQ problems would have been much more frequent, with 3/4 of the dwellings likely to exceed TVOC guidelines.

However if this is a problem in airtight dwellings, perhaps people enjoy better IAQ in leaky homes? Well, no, not necessarily.

In 2002, a study of ventilation and IAQ in 37 homes was published. Although they'd all been built since 1995, after Part L began to require buildings to attempt to keep out cold draughts, the homes were actually pretty much as leaky as the general UK stock – with ACH @50Pa ranging from 5 to 20, averaging around 12. Air change rates were estimated, and the indoor air pollutants carbon monoxide and nitrogen dioxide were recorded.[7]

Despite the leakiness of the sample, once again, the majority (68%) of the sample had below the recommended design air change rate of 0.5 ACH. Air change rates averaged around 0.4 ACH but over a wide range, with the poorest example only showing 0.19 ACH.

This study was different from the later one, though, in that occupants were free to use vents and windows as normal. However: "most occupants were unaware of trickle vent usage and they were fully open in only four homes and were fully closed in 13 of the homes. Those homes with trickle vents fully closed had the lowest ventilation rates in winter." In summer, things were better but nonetheless 30% of homes still had a whole house ventilation rate below 0.5 ACH.

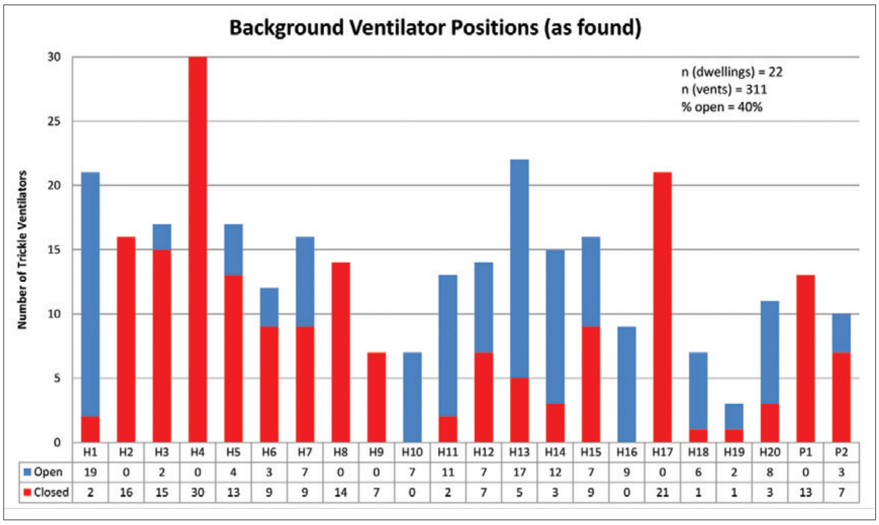
Some homes also suffered indoor air pollution issues: in winter 18% of the homes had kitchen CO levels above WHO guidelines, and even in summer, 13% did. In winter the kitchens of six homes also exceeded NO_2 guideline values – pollution was worse in homes with gas cooking, smoking, or high occupancy.

Occupant use of ventilation systems
It isn't known what the air change rates would have been with all vents open in this sample, but it's clear from differences in the results that occupant behaviour was a determining factor in ventilation rates even in these "leaky" homes: "Air change rates did not correlate especially closely with airtightness of the fabric, but there were clear trends for homes who reported vents and windows open most of the time to have the higher rates."[8]

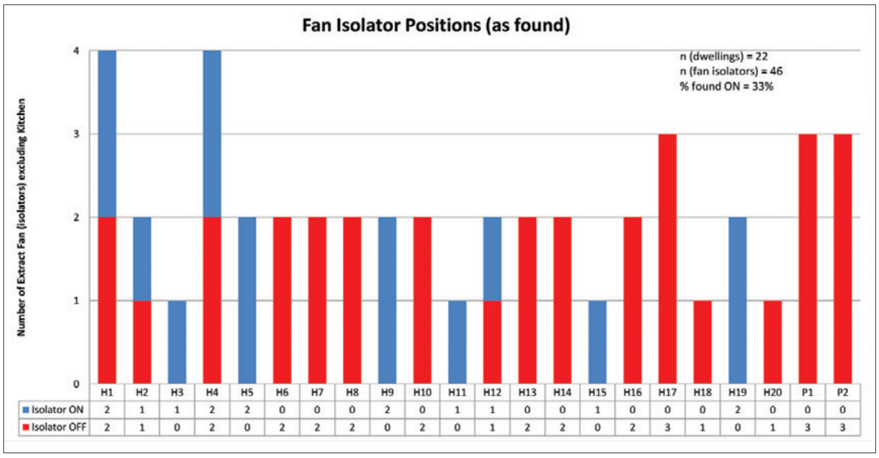
Thus even in the days before airtightness standards had begun to bite, occupant behaviour was key to air quality. As fabric has become more airtight, the regulatory requirements for background ventilation supplied via extract fans, trickle vents and window opening have been increased. While this has clearly been necessary, it does also mean that the relative importance of occupant behaviour has also steadily increased.

So are occupants keeping up, and modifying their behaviour to at least maintain the patchy air quality of yesteryear? Well, perhaps the most alarming finding of the 2009 DCLG study was one of the very first observations the researchers made.

When they first arrived, researchers examined the way ventilation was normally being used by the occupants day-to-day. The findings are well illustrated in the graphics below. In the first chart, the red portions of the bars represent closed vents, the blue, open; in the second, the blue bars represent extract fans with power supply connected, the red, those which had been turned off via the isolators.[9]



	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	P1	P2
Open	19	0	2	0	4	3	7	0	0	7	11	7	17	12	7	9	0	6	2	8	0	3
Closed	2	16	15	30	13	9	9	14	7	0	2	7	5	3	9	0	21	1	1	3	13	7



	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	P1	P2
Isolator ON	2	1	1	2	2	0	0	0	2	0	1	1	0	0	1	0	0	0	2	0	0	0
Isolator OFF	2	1	0	2	0	2	2	2	0	2	0	1	2	2	0	2	3	1	0	1	3	3

Thus overall, 60% of ventilators were found in the closed position, though 73% of occupants stated these were "usually open". Many occupants said they thought the vents caused draughts. With kitchen and bathroom extracts, six of the 22 households didn't use extract fans at all, five said they used the isolator to control some of their fans (though in fact many more did this); the reasons given were that the noise, and run-on timer, were a "nuisance". Only three of those households that did use kitchen extracts used them correctly – ie on boost while cooking; one household had requested and received a lower-power fan because the original was too noisy for them.

Bearing in mind that the patchy IAQ results reported in this study were with all vents open, the fact that there was usually a lot less ventilation in these homes has worrying implications for IAQ in the normal course of events.

Occupant impact was also highlighted in a Good Homes Alliance report[10] presenting examples of good ventilation practice in low energy homes. In the few projects with natural ventilation included (three with vents plus humidistat-controlled extract, two with passive heat recovery, and one with a passive stack system) two of the six dwellings had had poor IAQ, which was attributed to occupant behaviour - in both cases, occupants said they had closed vents/shut off fans because of noise or draughts. IAQ was poor in both cases.

Another, very recent study also shows that natural ventilation tends not to be used as intended and fails to give good IAQ. Stirling Howieson and colleagues in the faculty of engineering at the University of Strathclyde looked at 24 new-build homes constructed to 2010 regulations with an airtightness standard of 5m^3/m^2/hr@50Pa, where trickle vents in the windows provided the only source of background ventilation.[11]

CO_2 levels measured in occupied bedrooms

"were found to be at unacceptable concentrations" (occupied mean peak of 2317 ppm with a maximum of 4800 ppm). "Such high levels confirm that airtight dwellings with only trickle ventilators as the 'planned' ventilation strategy do not meet the standards demanded by the Building Regulations," the authors write, adding: "Such high concentrations of carbon dioxide are invariably found in bad company;" – with pollution from VOCs off-gassing from furniture and fittings liable to be leading to indoor air pollution, they suggest.

Some data is now also becoming available from the low-energy retrofits carried out under 'Retrofit for the Future'. A small case study of nine participating homes in Yorkshire, by URBED architect Marianne Heaslip, showed that over a cold but wet week of monitoring (in November 2011) relative humidity in the two homes with passive stack ventilation (with trickle vent inlets) was "at the higher end" of all the results, with RH ranging between 50% and 70%, except for one bedroom in one of the houses, where levels were between the high 70s and 90%. The one home with passive vents plus mechanical extract had high RH, ranging between 60 and 80%, and consistently above 70% in two of the three rooms monitored.

The researcher went on to observe, though, that "the residents of [the homes with the natural vents and PSV systems] were ... energy conscious, and appeared to have a tendency to shut their trickle vents".

How do we know when to open the vents?
As we saw at the start, among the benefits commonly ascribed to natural ventilation are that it's easy to understand, culturally familiar, and it "puts the occupant in control." The sense of being able to control indoor conditions is a real component of comfort – knowing they can alter them actually increases people's tolerance of less-than-perfect conditions.

So, while we are told that a "rapid, detectable response in IAQ correlates with satisfaction"[12] – what changes in IAQ can people actually detect?

The findings of the case studies reported by the Good Homes Alliance suggest we are not at all sensitive to high levels of CO_2 or relative humidity.

In one house, where there was a mean CO_2 of 1160ppm, and RH averaging near 70% and peaking at 90%, the occupant described the indoor air quality as 'good', but the GHA points out that "The IAQ in this dwelling is not 'good' and is presented for information only". In the other house with poor IAQ (as residents had closed most trickle vents and turned off fans in bathrooms and toilet, due to noise), the occupants did not complain of feeling stuffy "therefore this problem may not have been picked up without the monitoring".

Aside from steamy bathrooms and burnt toast, probably the most usual driver for increasing ventilation is not strictly IAQ, but occupants feeling too warm. People understand that it's usually cooler outside than in – and open the windows to make themselves more comfortable. For this reason, they will often understand a warm room to be "badly ventilated" even if ACH and RH happen to be good, and CO_2 and toxins are all acceptably low.

But of course what people are after here is not ventilation per se – it's cooling. And it seems that it is not just the unschooled ordinary user who makes this conflation, as we'll see below.

There are also suggestions that contrary to general expectation, buildings may become more airtight as they age – which may also present an issue for ventilation design recommendations.

But the fact that occupants can't automatically detect poor IAQ makes it inevitable that occupant controlled ventilation will be a hit-and-miss affair. In the studies above, many occupants in real life were indeed, missing not hitting, and living in conditions of underventilation, and unsatisfactory IAQ.

Energy efficient ventilation – or energy efficient cooling?
As well as being easy to understand and under occupant control, natural ventilation is often described as being energy efficient. For example, on the CIBSE website you can read: "Ventilation can be provided through a number of methods, the most energy efficient being a natural ventilation strategy."[13]

When you look more closely at commentary suggesting that natural ventilation is "energy efficient", you often find that the authors, like ordinary building users when asked about ventilation, tend to be thinking mainly about natural ventilation as cooling. (This is particularly common when the commentator deals with a lot of non-domestic building).

Of course, natural ventilation, or "opening a window" is indeed a very energy efficient means of cooling, and gives excellent occupant control, which is why so many mechanically ventilated buildings (including all such homes) also offer natural cooling via opening windows. For this reason the energy savings from natural cooling have to be considered separately from the energy savings/costs entailed by the background ventilation system of choice – they are separate services.

The other potential pitfall when comparing the energy use of two different (background) ventilation strategies is that one should endeavour to compare like with like. As Bob Lowe put it: "In households that place greater value on energy conservation than on air quality, it is possible for natural ventilation in an airtight house to outperform mechanical ventilation in terms of energy and carbon emissions, by the simple expedient of not opening the windows."

Thus, when comparing the energy used by different ventilation systems, it should be the energy used when delivering similar comfort conditions and IAQ in each case. But it's not always clear that this is allowed for.

Passive stack ventilation
Most of the discussion here has related to conventional "natural ventilation" ie with background ventilators, usually window trickle vents but also sometimes air bricks, plus mechanical extract in kitchens and bathrooms. There are even fewer studies on passive stack ventilation than there are on this more conventional system. Cranfield University's Derrick Crump who has reviewed most of the data that is available, has the impression that PSV performs similarly to the trickle vent/extract system in practice – "It's no better, but no worse," he told Passive House Plus.

More recent passive stack installations have tended to include "demand control" – humidity sensors to increase or decrease vent openings. However performance data is thin on the ground, and the most recent studies in dwellings have tended to be of fan-assisted passive stack ventilation.

Can natural ventilation be made to work reliably?
Certainly there are commentators who feel very strongly that the regulations, at least in the UK, are not fit for purpose when it comes to natural ventilation. Stirling Howieson is particularly critical of the gap between the "simplistic and unrealistic assumptions" used in mathematical modelling of ventilation – such as, that all doors would be open and all trickle ventilators unobstructed; his research has demonstrated that "in 'real life' situations, this is not the case and could lead to significant risks of underventilation." The regular occurrence of underventilation is confirmed by much of the research cited above: instances of one or other – or several – air quality problems were found in a significant proportion of all the homes studied.

It's been pretty much impossible to find whether the recommendations for natural ventilation in the building regulations for England and Wales, if installed and operated as the authors of Part F intend, deliver consistently good IAQ – there are just too few examples.

There's also a possibility that the regulatory targets for RH in particular are not ambitious enough – Part F (England & Wales) considers that a "monthly average" RH of 65% is satisfactory, as is a "weekly average" of 75%. ▶

This is "in order to lower the risk of condensation". There is however quite a bit of research suggesting that in order to reduce the risk of house dust mite problems (mites are known to exacerbate asthma in particular) RH below 60%, or even lower, should be sought. Thus the reviews of the Retrofit for the Future projects generally refer to RH below 70% as only "acceptable", with RH of 40%-60% described as "good".[14]

The fact that occupants can't automatically detect poor IAQ makes it inevitable that occupant controlled ventilation will be a hit-and-miss affair.

There are also suggestions that contrary to general expectation, buildings may become more airtight as they age – which may also present an issue for ventilation design recommendations.[15]

But the problem may be just as much cultural – or, even, philosophical, as it is technical. Who is, in the end, responsible for IAQ?

The regulations, and the designers and builders who follow them, make a tacit assumption that users will actively manage ventilation for good IAQ. And indeed, some do. But far too many don't, meaning this laissez-faire approach is costing health, and even lives.[16]

One often hears concerns that mechanical ventilation systems require a "whole culture change" or impose a "new lifestyle" on occupants. Yet it appears that a significant lifestyle change is required for many occupants to adapt to living safely in naturally ventilated homes now.

Technical solutions designed to deliver more consistent IAQ in natural ventilation systems, such as the use of CO_2 or moisture monitors either to control the ventilation, or to alert occupants to the need to adjust it, have been devised. But there's almost no monitoring data to demonstrate whether they actually work – and work to maintain low levels of pollutants that the sensors don't detect, such as VOCs, radon, or the products of combustion – without compromising energy saving or comfort. Until and unless data become available, neither designers, householders, nor the regulatory authorities can take a view on any of these new approaches. Yet again and again, as we have seen ad nauseam in the field of building energy use, we are offered calculations, but few actual facts. Performance data – and, critically, performance feedback to designers and installers, is pitifully scarce. (There is more monitoring data relating to mechanical ventilation and to hybrid systems, with and without sensor control – but still not a lot, and the issue of feedback to designers and installers is of course just as critical here.)

What we are facing could fairly be described as a "ventilation performance gap". As Amory Lovins famously said: "Any system without feedback is stupid". Without feedback, it's hard to see how the ventilation design, installation and operation systems in our homes will become fit for purpose.

It's becoming apparent that something has to change, as evidence mounts of the links between poor IAQ and a very distressing and expensive burden of ill-health. As people in fuel poverty reportedly ask for their gas to be cut off for fear of getting into debt[17], and the UK's "bedroom tax" and soaring rents force low-income households into smaller and smaller spaces, IAQ, and public health, is not going to be improving.

Let's hope that whatever solutions are proposed, are proposed on the basis of hard evidence that they actually work, when deployed in the homes of actual people.

[1]Alliance for Sustainable Building Products http://www.asbp.org.uk/
[2]http://www.building.co.uk/we-need-to-know-all-ventilation-systems-are-safe/5062555.article
[3]Assessment of MVHR systems and air quality in zero carbon homes NHBC Foundation August 2013
[4]Building Services, Engineering, Research & Technology 21 (3) 179-186 R. J. Lowe
Ventilation Strategy, Energy Use and CO_2 Emissions in Dwellings - a Theoretical Approach
[5]Ventilation and Indoor Air Quality in Part F 2006 Homes BD 2702 DCLG 2010
[6]"Are our homes making us ill?", Stirling Howieson, University of Strathclyde. Perspectives in Public Health 2014 in press https://pure.strath.ac.uk/portal/en/publications/are-our-homes-making-us-ill%280b8ce07f-b36d-499f-8caa-08c249f241ac%29.html
[7]VENTILATION AND INDOOR AIR QUALITY IN NEW HOMES Crump, Dimitroulopoulou et al BRE, Watford, http://www.umad.de/infos/cleanair13/pdf/full_104.pdf
[8]The preceding two studies also summarised in https://www.cranfield.ac.uk/about/people-and-resources/schools-and-departments/school-of-applied-sciences/groups-institutes-and-centres/ieh-reports-/air-pollution/w28.pdf
[9]http://manchesterismyplanet.com/energyandbuildings/gm-low-carbon-housing-retrofit, talk by Ian Mawditt.
[10]http://www.goodhomes.org.uk/downloads/news/VIAQ%20final%20120220%20-%20PUBLICATION.pdf
[11]https://pure.strath.ac.uk/portal/en/publications/are-our-homes-making-us-ill%280b8ce07f-b36d-499f-8caa-08c249f241ac%29.html http://bse.sagepub.com/content/early/2013/11/27/0143624413510307.abstract ($36)
[12]Fionn Stevenson, talk to Good Homes Alliance, 10 Nov 2010
[13]http://www.cibseenergycentre.co.uk/ventilation.html
[14]Residential Retrofit, Marion Baeli, RIBA books 2013. See also Lawrence Berkeley National Laboratory, http://www.iaq-science.lbl.gov/dampness-impacts.html
[15]In one NHBC study, eight of 23 homes became more airtight 1-3 years after completion. In the NHBC's Greenwatt Way study, 9 out of 10 homes became more airtight.
[16]As Stirling Howieson put it: "If policy action is not forthcoming, it is highly likely that the morbidity and mortality caused by the failure to take expedient action over asbestos in buildings, will be surpassed."
[17]http://www.theguardian.com/society/2013/dec/27/damp-social-housing-residents-heating-energy-bills

What ventilation is for:

- **Background ventilation: remove pollutants/replace with fresh air**
- **Cooling: remove unwanted heat**

Pollutants include

- **CO_2 from occupants**
- **Excess moisture from occupants and their activities (and also, possibly rain or groundwater getting into the building fabric)**
- **Chemical and particulate toxins and irritants from, for example, products of combustion (gas cookers, smoking, candles) cleaning products toiletries and "room fragrances", building components and finishes, hard and soft furnishings and appliances (eg plastics and resins, foam mattresses) and in non-domestic buildings, equipment such as printers and photocopiers**
- **Smells**
- **Radon from underground.**

In domestic buildings, moisture is often the most troublesome pollutant. High, variable and unpredictable amounts can be generated indoors, and when not removed it can lead to the proliferation of moulds and house dust mites, both of which cause or exacerbate serious and common health problems in many vulnerable people. As Lynn Sullivan, who chaired the 2009 Part F England & Wales working party, put it, drying a load of laundry indoors means releasing more than one and a half litres moisture into your home, "which is quite a challenge for any ventilation system".

Combustion products may exacerbate both asthma and cardiovascular disease; Radon, VOCs and some combustion products are also implicated in cancer, in particular, lung cancer.

In non-domestic buildings, CO_2 may be the pollutant which is likeliest to build to unwanted levels, and high occupancy means that if ventilation is inadequate levels may be high enough to affect alertness. This has been borne out by monitoring studies in schools.

glossary

*Perplexed by all this talk of U-values, blower door tests and embodied energy? This latest instalment of our sustainable building glossary will help you get to grips with the key terminology. These entries will be added to an online glossary at **www.passive.ie/glossary**, which will continue to grow in detail as each new issue comes out.*

Air-to-water heat pumps use outside air as a heat source and delivers it to internal spaces via hot water (eg underfloor heating pipes) using electricity to boost the temperature.

BREEAM This is the Building Research Establishment's Environmental Assessment Method, a UK system used to assess the environmental impact of non-domestic buildings. It considers a range of criteria including energy consumption, water, materials, waste, transport, ecology, pollution and health. It has five levels: pass, good, very good, excellent and outstanding. As with competing rating systems such as the US LEED and German DGNB systems, BREEAM is gaining popularity internationally, often used by public sector and multinational clients.

Brise soleil A permanent structure designed to provide shade from the sun. In the northern-hemisphere these are often placed on a building's south-facade to help prevent glare and overheating. Some innovative approaches to brise soleil include planting deciduous climbers to provide extra summer shading and more passive solar gain in winter.

Building envelope/fabric The exterior 'shell' of the building, including the external walls, windows, ground floor and roof.

Code for Sustainable Homes The BRE's environmental assessment tool for dwellings. As with BREEAM (see above), buildings are assessed on their overall environmental performance, resulting in six levels of scoring.

District heating A type of heating system in which heat is piped from a large central heating system (such as a boiler) to multiple units (such as houses or apartments), rather than each unit having its own separate heat source. Often financed via energy service companies (ESCos), district heating systems tend to become less viable in very energy efficient buildings, given that the low space heating demand means smaller bills payable to the ESCos.

Enerphit This is the Passive House Institute's standard for retrofit projects. It demands airtightness of 1.0 air changes per hour and space heating demand of 25kWh/m^2/yr (as opposed to 0.6 air changes per hour and 15 kWh/m^2/yr for the original passive house standard).

Intelligent vapour check/membrane A type of membrane, often used in timber frame construction – and timber roof structures – that becomes more or less permeable to water vapour depending on ambient conditions. Typically in winter it prevents water vapour from getting in but becomes more vapour permeable in summer to allow water vapour to diffuse out and building components to dry.

MVHR or mechanical ventilation with heat recovery, to give it its full name, also known as heat recovery ventilation. This is a system that ventilates a building while also recovering heat from extracted air. It's typically installed as a centralised "whole building solution, but decentralised systems are emerging too, including single room ductless systems. MVHR systems typically extract warm, damp air from 'wet' rooms like kitchens and bathrooms and use it to heat cool, fresh incoming air, which is then usually piped to living spaces such as living rooms and bedrooms.

Performance gap The difference between how a building is designed to perform and how it subsequently does in reality once built. The term usually refers to energy consumption but can refer to other aspects of building performance too.

PHPP This is the Passive House Planning Package, the spreadsheet-based software that is used to design, verify and certify passive house and Enerphit projects.

Psi (ψ) values This is the 'linear thermal transmittance', the rate of heat flow per degree temperature difference per unit length of a thermal bridge. It is measured in W/mK, and is used to calculate the heat loss or gain through a thermal bridge. Under Irish and UK building regulations, the Psi-values for all non-repeating thermal bridges are multiplied by the measured length of each bridge before a Y-value for the building can be calculated, expressed in W/m^{2}K.

Relative humidity This is the amount of water vapour in the air relative to the amount the air can hold at the current temperature. Healthy relative humidity is generally regarded as being between 40% and 60%. High relative humidity can lead to condensation, dampness and mould.

Seasonal performance factor The ratio of useful heat energy output from a heat pump to the electrical energy input (including compressor, circulation pumps and electrical immersion, if present) averaged over an entire heating season.

Solar gain This refers to the heat energy that a building receives passively from the sun, normally through its glazing.

Space heating demand The amount of active heating input required to heat a building usually expressed in kWh/m^2/yr. It is often calculated using building energy software applications such as PHPP, Deap or Sap.

Strip foundation A strip of concrete running under all of a building's load bearing walls. This will normally include the external walls, and possibly some of the internal walls.

Surface to volume ratio This is the total external surface area of a building relative to its volume. A lower surface to volume ratio is generally more energy efficient, as it means there is less surface area from which heat can escape the building.

Thermal bridging, alternatively known as cold bridging, occurs when heat or cold transfers across an external surface of a building. This can cause heat to escape from the building or cold to enter. Thermal bridging occurs when a thermally conductive material (ie a material with low resistance to heat flow) penetrates or bypasses the insulation layer.

Thermostatic radiator valves are self-regulating valves, typically attached to radiators or other water heating systems, used to control the room temperature automatically based on what temperature the TRVs are set at.

U-value The U-value of a material is the rate of heat loss through that material. The lower the U-value of a material, the less heat can pass through it and the better it is at insulating. U-values are measured in watts per metre squared kelvin (W/m^{2}K).

Wall ties Material that bridges a wall cavity to join the inner and outer skins. They can be a point of thermal bridging but some modern wall ties are made from less thermally conductive materials.

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Passive House windows need active expertise.

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Case study: Bath University HemPod
Bath University chose Janex for its HemPod experimental building. They contributed to an air-tightness that comfortably met Passive House standards.

For more on the research visit
www.janex.co.uk/news/headline-news/hemp-pod-info.aspx

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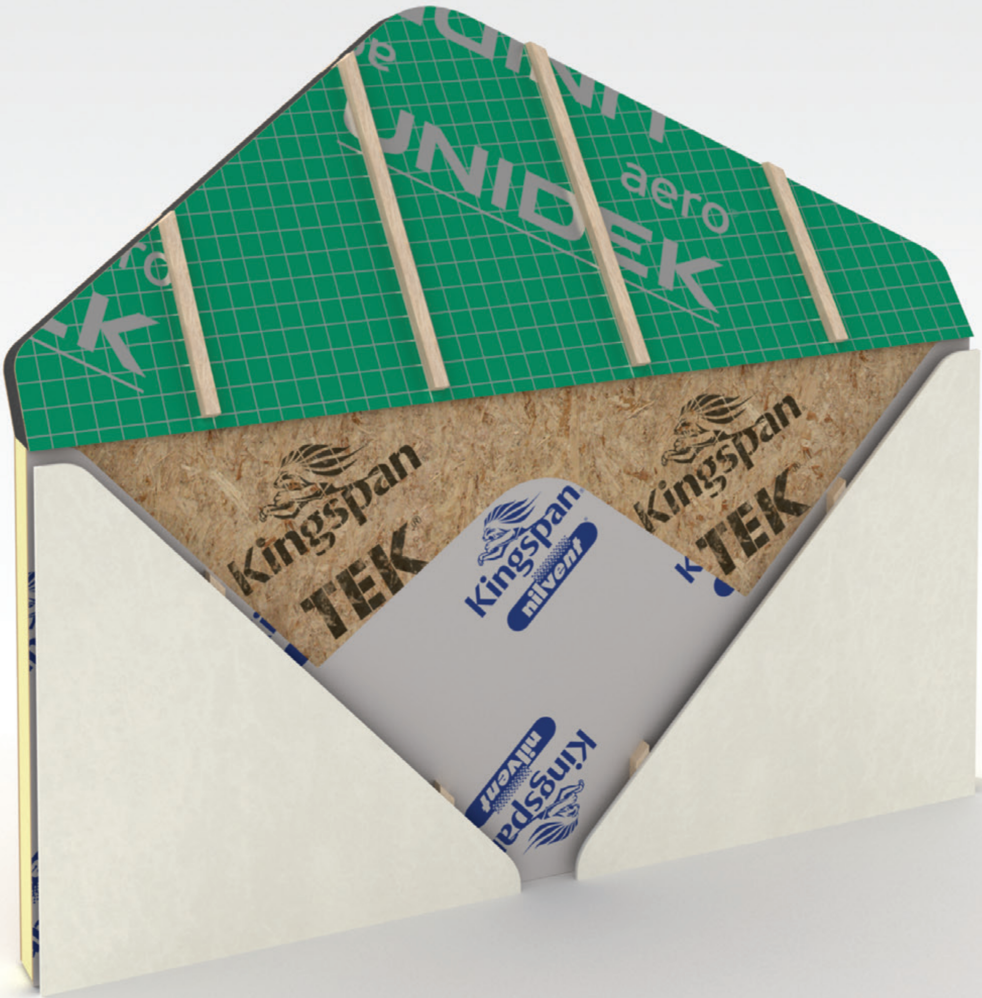

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